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User Manual

Tektronix

OA 5000 Series
Optical Attenuators

070-7612-06

www.tektronix.com

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EC Declaration of Conformity

We

Tektronix UK Ltd.
The Arena
Downshire Way
Bracknell, RG12 1PU

declare under sole responsibility that the

OA5000 Series Optical Attenuators

OA5002, OA5012, OA5022, and OA5032

Including the OCP5502 Power Module

meet the intent of Directive 89/336/EEC for Electromagnetic Compatibility and Low Voltage Directive 73/23/EEC for Product Safety.

Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EMC Directive 89/336/EEC:

EN 61326	EMC requirements for Class A electrical equipment for measurement, control, and laboratory use
IEC 61000-4-2	Electrostatic Discharge Immunity (Performance Criterion B)
IEC 61000-4-2	RF Electromagnetic Field Immunity (Performance Criterion A)
IEC 61000-4-2	Electrical Fast Transient / Burst Immunity (Performance Criterion B)
IEC 61000-4-2	Power Line Surge Immunity (Performance Criterion B)
IEC 61000-4-2	RF Conducted Immunity (Performance Criterion A)
IEC 61000-4-2	Power Line Voltage Fluctuation Immunity (Performance Criterion B)
EN 61000-3-2	AC Power Line Harmonic Emissions

This product meets the essential requirements in Annes 1 of the Low Voltage Directive 73/23/EEC, amended by 93/68/EEC:

EN 61010-1/A1	Safety requirements for electrical equipment for measurement, control, and laboratory use

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Welcome

Congratulations on your purchase of an OA 5000 Series Optical Attenuator. The OA 5000 Series Optical Attenuators are high-performance instruments used to attenuate optical signals. The OA 5000 Series consists of four instruments, the OA 5002, OA 5012, OA 5022, and OA 5032. The major difference between the models is the optical fiber connection. The OA 5002 is used with single-mode fiber; the OA 5012, with 50 μm multimode fiber; the OA 5022, with 62.5 μm multimode fiber; and the OA 5032, with 100 μm fiber. Some of the outstanding characteristics of the OA 5000 Series are:

- Attenuation to 60 dB — the OA 5000 can attenuate signals up to 60 dB in steps of 0.01 dB. A shutter provides greater than 100 dB attenuation for the OA 5002, OA 5012, and OA 5022. The shutter provides greater than 90 dB attenuation for the OA 5032.
- 600 nm to 1700 nm calibrated spectral response in one unit.
- Linear response within ±0.05 dB.
- Ability to store attenuation levels, which is useful for repeat measurements.
- GPIB Programmable — the OA 5000 Series conforms to IEEE Std 488.2.
- Models for both Single and Multimode Fiber.

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Safety

You might be eager to begin using your OA 5000, but please take a moment to review these safety precautions. They are provided for your protection and to prevent damage to the Optical Attenuator. This safety information applies to all operators and service personnel.

Symbols and Terms

These two terms appear in manuals:

- CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.
- WARNING statements identify conditions or practices that could result in personal injury or loss of life.

These two terms appear on equipment:

- *CAUTION* indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.
- *DANGER* indicates a personal injury hazard immediately accessible as one reads the marking.

This symbol appears in manuals:



Static-Sensitive Devices

These symbols appear on equipment:



DANGER
High Voltage



Protective
ground (earth)
terminal



ATTENTION
Refer to
manual

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Specific Precautions

Observe all of these precautions to ensure your personal safety and to prevent damage to either the OA 5000 or equipment connected to it.

Optical Output

WARNING

To prevent damage to your eyes, avoid looking into the optical output port while there is an optical signal connected to the input port. Even if the OA 5000 is switched off, light can pass through the attenuator. Always attach the output port to a receiver before attaching the source signal to the input port.

Power Source

The OA 5000 is designed for operation in a Tektronix TM 5000 Series Power Module or the right-hand slot of an Tektronix OCP 5502. To ensure safe operation, follow all precautions listed in the instrument's Operators Manual. Do not attempt to operate the OA 5000 with any other power source.

Grounding the Optical Attenuator

The OA 5000 is grounded through the power module. To avoid electric shock, plug the power module power cord into a properly wired receptacle where earth ground has been verified by a qualified service person.

Without the protective ground connection, all parts of the OA 5000 are potential shock hazards. This includes knobs and controls that may appear to be insulators.

Use the Proper Power Cord

Use only the power cord and connector specified for your TM 5000 Series Power Module. Use only a power cord that is in good condition.

Use the Proper Fuse

To avoid fire hazard, use only the fuse specified in the parts list for your TM 5000 Series Power Module, and which is identical in type, voltage rating, and current rating.

Do Not Remove Covers or Panels

To avoid personal injury, do not operate the OA 5000 or TM 5000 Series Power Module without the panels or covers.

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Do Not Operate in Explosive Atmospheres

The OA 5000 provides no explosion protection from static discharges or arcing components. Do not operate the OA 5000 in an atmosphere of explosive gasses.

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A Quick Tour

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Installation

The OA 5000 Optical Attenuator is designed to operate in a Tektronix TM 5000 Series Power Module or the right-hand slot of a Tektronix OCP 5502. To ensure safe operation, follow all precautions listed in the Power Module's Operator Manual. Do not attempt to operate the OA 5000 with any other power source.

Install the OA 5000 as follows:

☐ **Step 1:** Plug the TM 5000 Power Module or OCP 5502 into an appropriate AC power source.

CAUTION

To prevent possible instrument damage, make sure the power module is turned off before inserting the OA 5000.

☐ **Step 2:** After ensuring the power module is turned off, align the top and bottom grooves of the OA 5000 with the rails of the power module (in the right-hand slot of the OCP 5502) and slide the OA 5000 in until the edge connector snaps into place. See Figure 1-1. The OA 5000 front panel should be flush with the power module cabinet.

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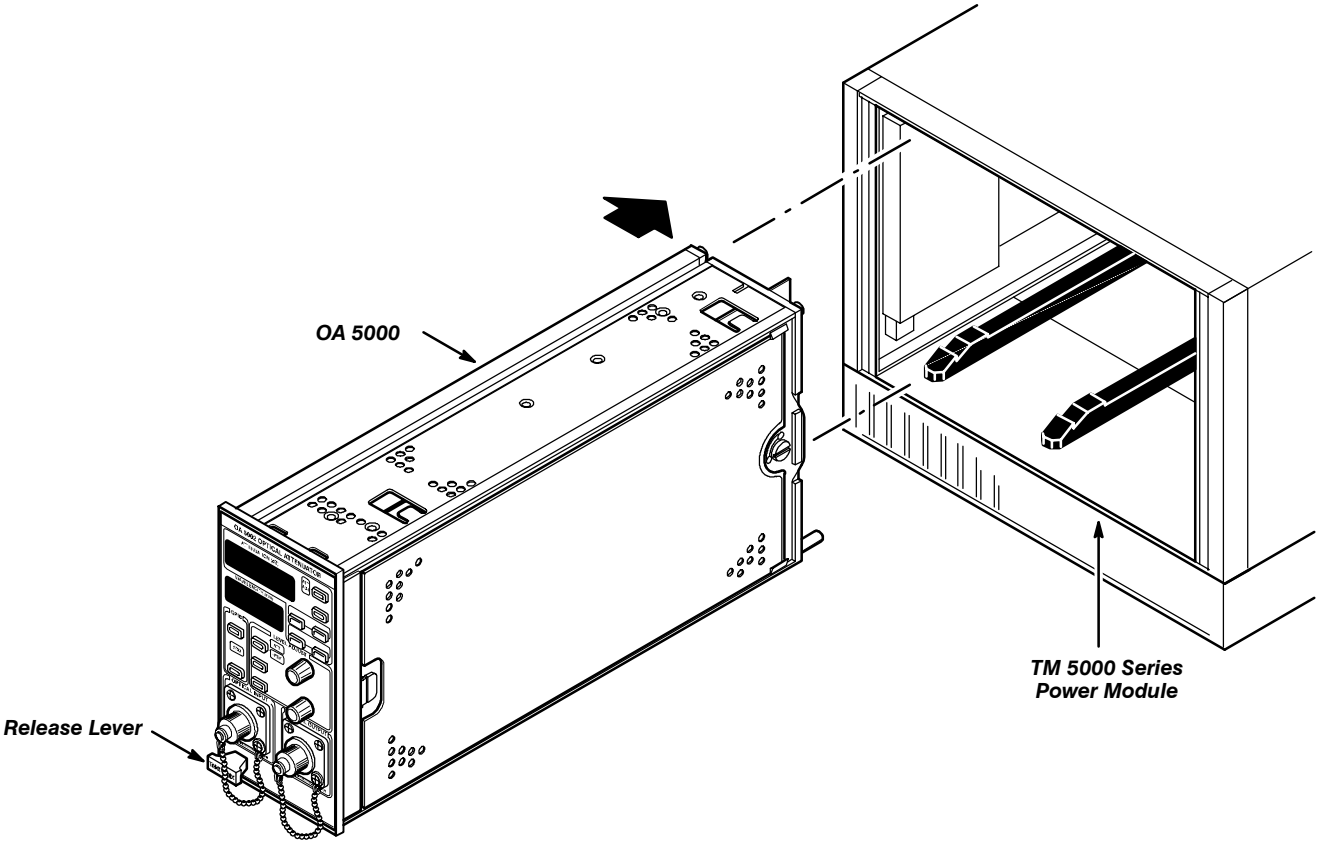


Figure 1-1: Installing the OA 5000 into the Power Module

If you will be programming the OA 5000 over the GPIB, perform the following additional step:

☐ **Step 3:** Attach the GPIB cable from your instrument controller to the GPIB connector located on the back of the TM 5000 Power Module.

Removing the OA 5000

Before removing the OA 5000 from the power module, turn the power module off.

To remove the OA 5000 plug-in, grab the release lever and pull the instrument out.

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A Quick Tour

This section provides a brief overview of the OA 5000 Optical Attenuator. The overview illustrates how easy it is to learn about and use the OA 5000.

You can read this section or you can choose to investigate the OA 5000 on your own. If you decide not to read the overview, refer to the *User Reference* section to answer any questions you may have. *User Reference* also describes details and features not covered in this section.

In this section you will set up the OA 5000 and change various settings to show get a feel for how the OA 5000 works. You will not be using any optical signals.

Figure 1-2, on page 1–4, presents a front panel view of the OA 5000.

Preset the OA 5000

If you have not already done so, install the OA 5000 as described on page 1–1 and turn on the instrument.

☐ **Step 1:** Press **MODE** so that the **ATT** indicator is lit and **–REF** is not lit.

This sets the OA 5000 to display attenuation in absolute units rather than displaying attenuation relative to a reference value.

☐ **Step 2:** Press **WAVELENGTH**. The word SET will appear in the attenuation display.

☐ **Step 3:** Using the **COARSE** and **FINE** knobs, set the **WAVELENGTH** to 1300 nm.

The actual attenuation of an optical input signal varies depending on the wavelength of the signal. To ensure accurate attenuation readings, set **WAVELENGTH** to the wavelength of the signal you are attenuating.

☐ **Step 4:** Press **WAVELENGTH** again to accept the new wavelength value.

☐ **Step 5:** Press **DISABLE**, so that it is not lit.

If the **DISABLE** button is lit, the shutter inside the OA 5000 blocks the signal path, providing ≥100 dB attenuation for the OA 5002, OA 5012, and OA 5022, and ≥90 dB attenuation for the OA 5032. When the **DISABLE** button is not lit, the shutter is withdrawn from the optical signal path, enabling you to set the attenuation value from 0 to 60 dB in 0.01 dB increments.

☐ **Step 6:** Press **MIN ATT**.

This sets the OA 5000 to 0 dB attenuation.

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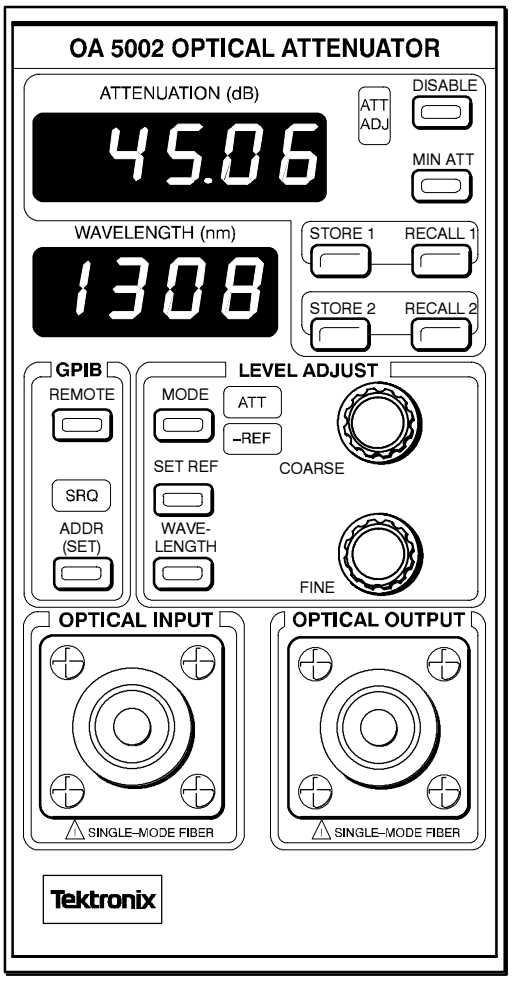


Figure 1-2: OA 5002 Front Panel

Storing and Recalling Settings

Use the store and recall buttons to save one or two attenuator settings for use at a later time.

- ☐ **Step 7:** Using the **COARSE** knob, set the attenuation to 10.00 dB.
- ☐ **Step 8:** Store the attenuation setting by pressing **STORE 1**.
- ☐ **Step 9:** Change the attenuation setting, using both the **COARSE** and **FINE** knobs, to 21.50 dB.
- ☐ **Step 10:** Store the attenuation setting by pressing **STORE 2**.
- ☐ **Step 11:** Press **MIN ATT** and then press **RECALL 1**.

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Check the **ATTENUATION** readout and verify that it is set to 10.00 dB.

☐ **Step 12:** Press **RECALL 2**.

Check the **ATTENUATION** readout and verify that it is set to 21.50 dB.

Setting a Reference Value

The **SET REF** button allows you to set a reference value for the attenuation. You can then measure attenuation relative to this set value.

☐ **Step 13:** Press **MIN ATT**.

This sets the OA 5000 to 0 dB attenuation.

☐ **Step 14:** Press the **SET REF** button.

The word **SET** will appear in the wavelength display. The reference value can now be adjusted with the **COARSE** and **FINE** knobs.

☐ **Step 15:** Adjust the reference value for −8.00 dB using the **COARSE** and **FINE** knobs.

☐ **Step 16:** Press the **SET REF** button to accept the displayed value. The display will return to normal.

☐ **Step 17:** Press the **MODE** button.

Notice that the **–REF** indicator is lit, indicating that the attenuation display is now displaying attenuation relative to a reference value. The attenuation display shows 8.00 dB and the **MIN ATT** button is lit.

☐ **Step 18:** Using the **COARSE** knob, adjust the attenuation to 10.00 dB.

☐ **Step 19:** Press the **MIN ATT** button. Check that the attenuation readout has changed to 8.00 dB and the **MIN ATT** button is lit.

The attenuation display reads 8.00 dB, instead of 0.00 dB, because the display is still in reference mode and the reference value is (−8.00). Pressing **MIN ATT** will set the OA 5000 to 0.00 dB only if the display is not in reference mode or the reference value is 0.00 dB.

☐ **Step 20:** Recall the first stored setting by pressing **RECALL 1**.

Remember that you set **STORE 1** to 10.00 dB. Note that the attenuation readout is 18.00 dB. The display shows the value: 10.00 − (−8.00)= 18.00 dB.

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☐ **Step 21:** Recall the second stored setting by pressing **RECALL 2**.

Note that the attenuation readout is now 29.50 dB. Remember that you set **STORE 2** to 21.50 dB. The display shows the value: 21.50 – (–8.00)= 29.50 dB.

☐ **Step 22:** Push the **MODE** button so that just the **ATT** indicator is lit, and then push **MIN ATT**.

Notice that the **ATTENUATION** display is now 0.00, because you pressed the **MIN ATT** button and the display is no longer in reference mode.

Settings at Power Up

One last thing to note are the settings used at power up. When you power down the OA 5000, it saves the attenuation setting, the mode, the wavelength, and reference levels. The next time you power up the OA 5000, it will return to the settings stored when it was last powered down.

This completes the tour of the OA 5000.

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User Reference

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Operator Overview

The User Reference Section

The User Reference section is arranged as an alphabetic list of topics. Each topic covers one aspect of the operation of the OA 5000. Five topics follow this operator overview:

- Enabling/Disabling Attenuation
- Setting Attenuation Levels
- Setting the GPIB Address
- Setting the Reference Level
- Storing and Recalling Attenuation Levels

Figure 2-1, on page 2–2, details the controls located on the OA 5000 front panel.

NOTE

If, after power-up, the decimal points in the WAVELENGTH display are flashing, the unit has lost its calibrator values and needs to be recalibrated. Contact your local service center.

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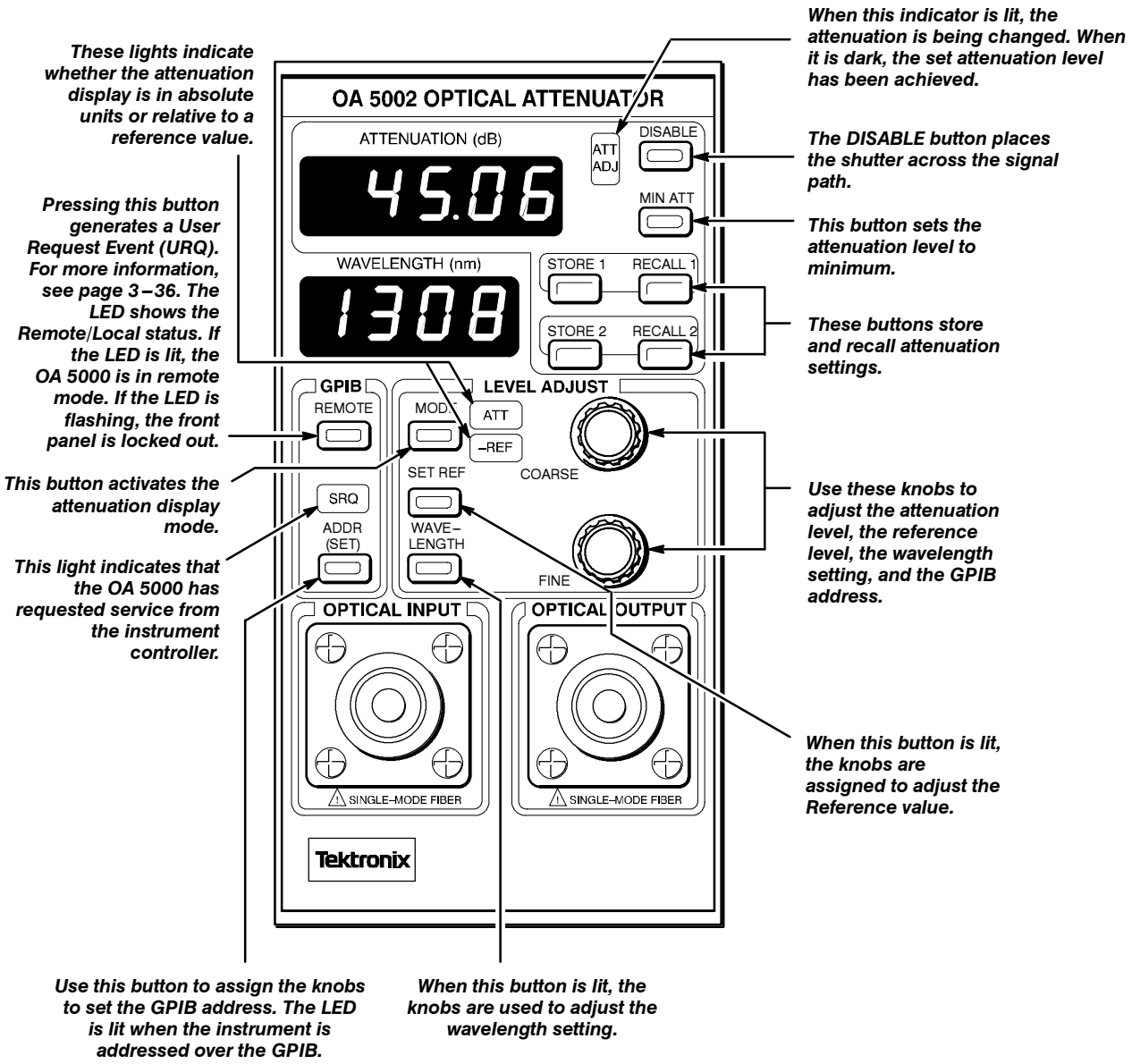


Figure 2-1: OA 5002 Front Panel

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Enabling/Disabling Attenuation

On the OA 5000, the **DISABLE** button (Figure 2-2) allows you to enable or disable the optical path through the attenuator with a shutter. You can still set the attenuation level, however, since it is not dependent on the optical signal passing through the attenuator. For example, you can block the passage of the optical signal through the attenuator by disabling attenuation, setting the attenuation level, then enabling attenuation and your signal will be attenuated to the desired level immediately.

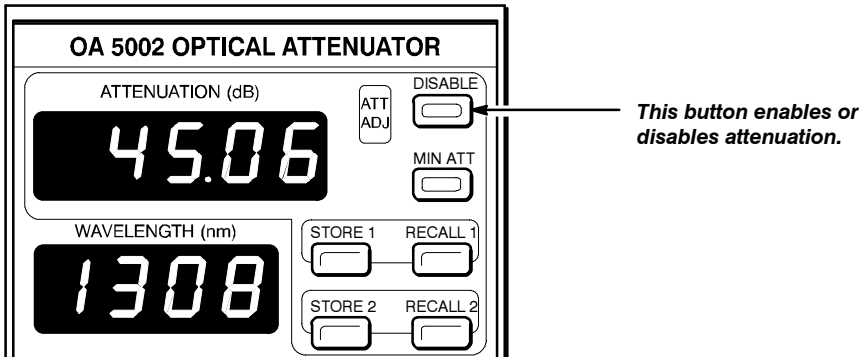


Figure 2-2: The Location of the DISABLE Button

To enable attenuation, press the **DISABLE** button on the front panel so that the button is *not* lit. When the **DISABLE** button is not lit, the optical signal passes through the attenuator.

To disable attenuation, press the **DISABLE** button so that it *is* lighted. When the **DISABLE** button is lighted, the internal shutter is placed across the optical path, providing ≥100 dB attenuation for the OA 5002, OA 5012, and OA 5022, and ≥90 dB attenuation for the OA 5032.

WARNING

To prevent damage to your eyes, avoid looking into the optical output port while there is an optical signal connected to the input port. The disable function is only valid while the instrument is switched on. When the OA 5000 is switched off, the shutter withdraws from the optical path and the light is attenuated only by the previous attenuator setting.

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Setting Attenuation Levels

Because the OA 5000 automatically adjusts the attenuator to correct for different wavelengths, it is important, for attenuator accuracy, to correctly match the displayed wavelength with the wavelength of the signal going into the unit.

Setting attenuation levels on the OA 5000 requires you to perform two procedures in the following order:

1. Specify the wavelength of the signal to be attenuated.
2. Set the level of attenuation.

Refer to Figure 2-3.

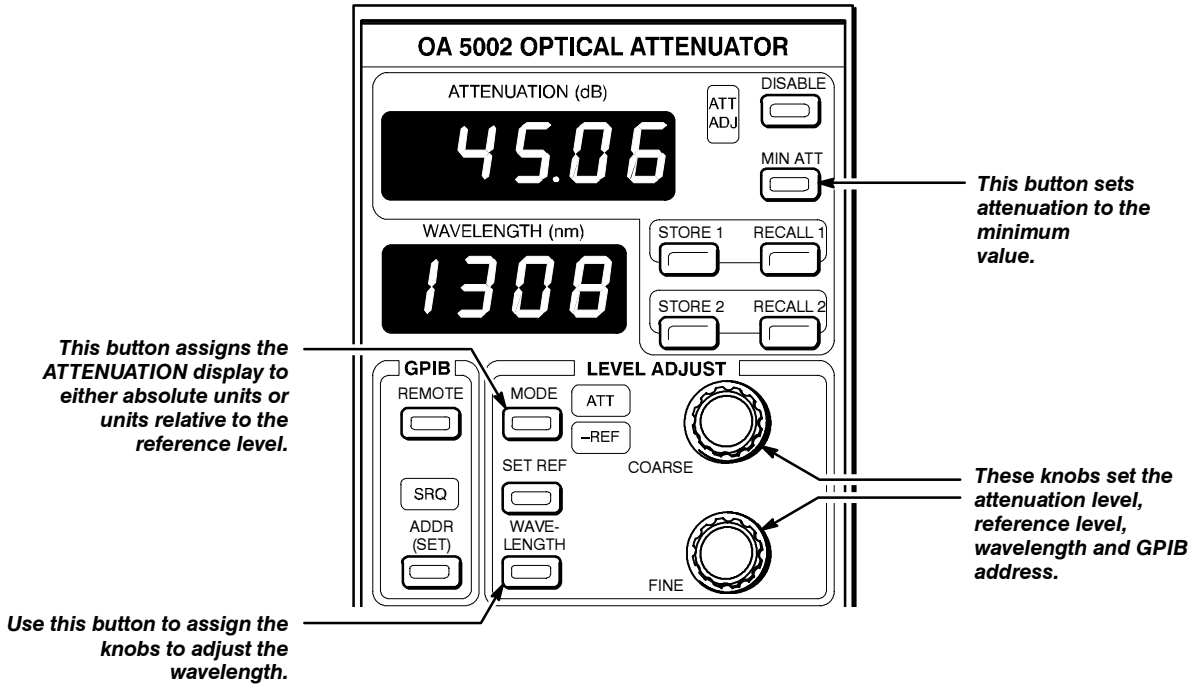


Figure 2-3: Setting Attenuation Levels

Specifying the Wavelength

To specify the wavelength to be attenuated:

☐ **Step 1:** Press the **WAVELENGTH** button.

The word **SEt** will appear in the attenuation display and the **WAVE-LENGTH** button will illuminate.

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☐ **Step 2:** Use the two knobs to adjust the displayed wavelength value.

The **COARSE** knob changes the displayed value by 10 nm per click and the **FINE** knob changes the displayed value by 1 nm per click. The wavelength can be adjusted from 600 to 1700 nm.

☐ **Step 3:** When the desired wavelength is displayed, press **WAVELENGTH** again to accept the new displayed value. The OA 5000 will return to the previous attenuation display mode.

Setting the Attenuation Level

To set the attenuation level once you have set the wavelength:

☐ **Step 1:** Set the attenuation display mode by pressing the **MODE** button.

The attenuation display shows the current attenuation value in one of two modes, absolute or relative to a reference value. Pressing the **MODE** button, while it is illuminated, toggles between these modes.

When the **ATT** light is on and the **–REF** light is off, the displayed attenuation is in absolute mode. In this mode, the displayed attenuation is the value relative to its absolute minimum setting. The minimum value in this mode is always 0 dB.

When both the **ATT** and **–REF** lights are on, the displayed attenuation value is the absolute attenuation value minus the value of the reference (refer to the section *Setting the Reference Value* to set the reference). The **COARSE** and **FINE** knobs still adjust the attenuation value as with absolute mode. The only difference is the value displayed in the attenuation display.

☐ **Step 2:** Set the desired attenuation value by adjusting the **COARSE** and **FINE** knobs. The **COARSE** knob changes the attenuation by 1 dB per click and the **FINE** knob changes the attenuation by 0.01 dB per click.

NOTE

Switching between the absolute and relative display modes does not change the actual attenuation value but only the value displayed.

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Setting the Attenuation Level to Minimum

To set the attenuation level to minimum, press the **MIN ATT** button.

Setting the attenuation to minimum sets the absolute attenuation to 0 dB. This means that the OA 5000 is not attenuating the optical input. However, the attenuation display may not read 0 dB. As noted above, if the attenuation display mode is set to relative, the attenuation display will show the absolute attenuation value (0 dB after pressing **MIN ATT**) minus the value of the reference. If the reference value is non-zero, then the attenuation display will not be 0 dB after pressing **MIN ATT**.

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Setting the GPIB Address

Setting the GPIB address is accomplished using the **ADDR (SET)** button and the **LEVEL ADJUST** knobs (Figure 2-4).

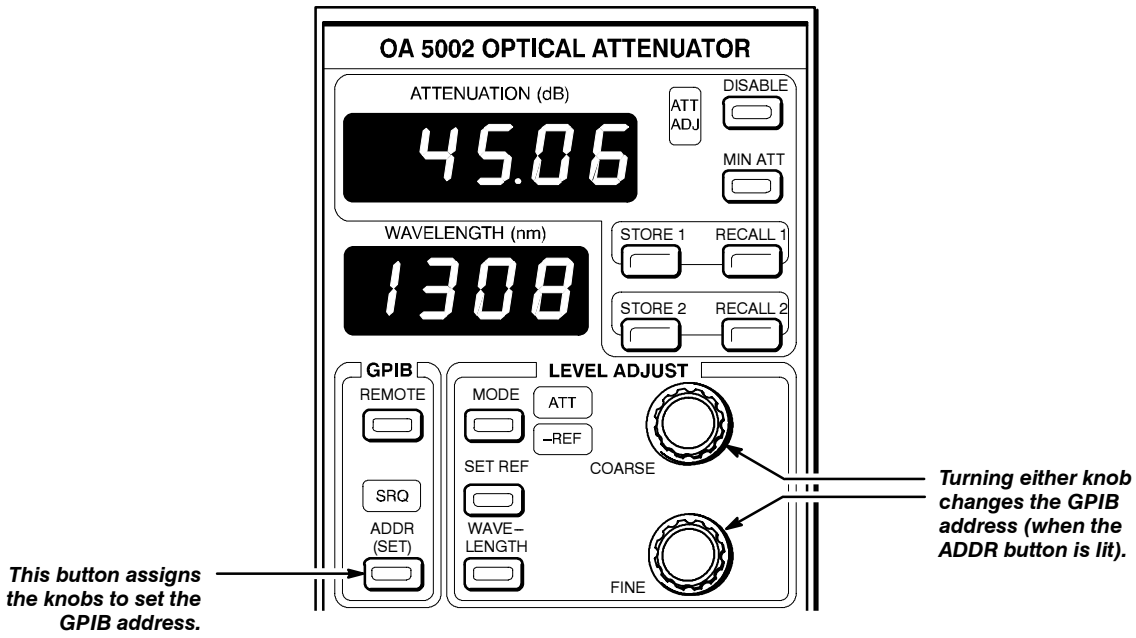


Figure 2-4: The Location of the ADDR (SET) Button

To set the GPIB address:

- ☐ **Step 1:** Press the **ADDR (SET)** button so that it is lighted. The **ATTENUATION** display will change to read **Addr** and the GPIB address will be displayed in the **WAVELENGTH** display.
- ☐ **Step 2:** Use either the **COARSE** or **FINE** knobs to change the address.
- ☐ **Step 3:** When the address is set, press the **ADDR (SET)** button again to enter the change of address.

The **ADDR (SET)** button also indicates the addressed status of the OA 5000 from the GPIB (when the GPIB address is *not* being set). When the button is lit, the OA 5000 has been addressed to talk or listen by a controller on the GPIB.

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NOTE

Valid GPIB addresses are 0 through 30. If the GPIB address is increased past 30, the display will show the word "OFF." If OFF is entered as the address, the OA 5000 will not be addressable over the GPIB and it will not participate in any GPIB transactions.

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Setting the Reference Level

You can set the display of the OA 5000 to reflect the attenuation of the system rather than just the attenuation provided by the OA 5000. For example, if your system insertion loss is 1.55 dB, you could set the reference value to −1.55 dB and the attenuation displayed would range from 1.55 dB to 61.55 dB, instead of 0 dB to 60 dB.

Use the following procedure to set the reference level:

- ☐ **Step 1:** Press **SET REF** so that it is lit (Figure 2-5).
- ☐ **Step 2:** Adjust the reference level using the knobs.
- ☐ **Step 3:** After setting the reference level, press the **SET REF** button again.

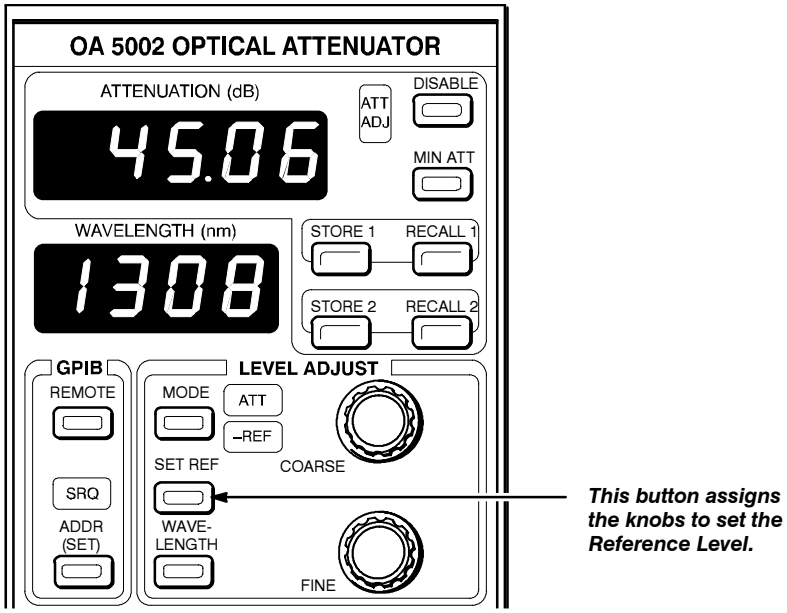


Figure 2-5: The Location of the SET REF Button

Once you have set the reference level, you may wish to change the attenuation display mode. To set the display mode so that the reference level is subtracted from the attenuation provided by the OA 5000, press the **MODE** button so that the **–REF** indicator is lighted.

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The reference mode has two primary applications:

1. Reading total attenuation (insertion loss)
2. Approximating signal power

Measuring Insertion Loss

The total attenuation of any attenuator is the sum of the attenuation caused by the connections (the insertion loss) and the attenuation caused by the active element. Since the insertion loss is dependent on many factors, it is hard to determine this value precisely. Some of the factors that affect insertion loss are the condition of the connectors, the cleanliness of the connectors, and the mode pattern of the fiber. Nonetheless, you can measure insertion loss.

- ☐ **Step 1:** Connect a stable source to an optical power meter using two optical cables that have been joined with an in-line adapter.
- ☐ **Step 2:** Measure the power on a suitable optical power meter and measure the optical power in dBm.
- ☐ **Step 3:** Disconnect the cables at the in-line adapter and connect them to the optical attenuator (which should be set at minimum attenuation).
- ☐ **Step 4:** Measure the resultant power in dBm.

The insertion loss (within the connector uncertainty) is the difference between the power reading with only the optical cables and the reading with the cables plus the attenuator. The insertion loss specification for the OA 5000 attenuators is $\leq$2.0 dB. The total attenuation is the insertion loss plus the attenuation level shown on the OA 5000. Thus, by setting the reference level to the value of the insertion loss and enabling the reference display mode, the OA 5000 can display the total attenuation of the attenuation system.

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Approximating Signal Power

The second application for reference mode is approximating signal power after the source has been attenuated.

- ☐ **Step 1:** Set the attenuator to its minimum reference level.
- ☐ **Step 2:** Measure the power (in dBm) from the fiber connected to the output optical connector.
- ☐ **Step 3:** Set the reference value to this number.

Once this level has been set and the OA 5000 is in reference mode, the displayed attenuation is the negative of the power level in dBm. For example, if the power level is −2.5 dBm when the attenuator is at its minimum attenuation level and this is entered as the reference level, then the display will read 2.5 dB when set to REF mode. Then, if you increase the attenuation by 10 dB, the display will read 12.5, which is the negative of the power level in dBm.

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Storing and Recalling Attenuation Levels

The OA 5000 can store two attenuation levels for later recall. This can help save you time and minimize mistakes. Refer to Figure 2-6.

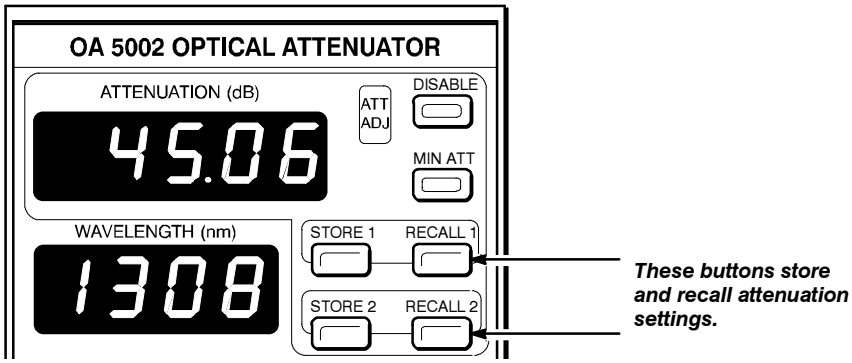


Figure 2-6: The Location of the STORE and RECALL Buttons

To store an attenuation setting

- press either **STORE1** or **STORE2**.

The current attenuation setting will be stored. The **ATTENUATION** display will blink once to indicate acceptance of the value.

NOTE

When you press STORE1 or STORE2, the only setting saved is the attenuation setting. The wavelength setting is not stored. If the wavelength of your signal has changed since the attenuation setting was stored, you will have to adjust the wavelength setting to ensure accurate attenuation.

To recall an attenuation setting

- press either **RECALL1** or **RECALL2**.

The selected setting will be recalled.

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Programming

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Setting Up the Instrument

This section tells you how to prepare the OA 5000 Optical Attenuator for use with a remote controller or computer. The first part of this section explains how to connect the OA 5000 to a controller or computer through the **GPIB** interface. The rest of the section describes how to use the OA 5000 front panel settings to enable the OA 5000 to send and receive messages to and from a remote controller.

NOTE

In addition to the information in this manual, you will need to consult the documentation for your controller to determine how to send commands, send interface messages such as local lockout and serial poll, and receive query responses from within the programming language running on your controller or computer. Also, you will need to determine how to assert various GPIB lines, including remote enable and attention from within the programming language running your controller or computer.

Controllers

You can control the OA 5000 with a remote controller or computer that uses the IEEE Std 488.1-1987 (GPIB) interface.

Using the GPIB Interface

The OA 5000 is connected to the GPIB through the TM5000 Series power module in which it is installed. Connect the TM5000 power module to the GPIB using an IEEE Std 488 GPIB cable (available as Tektronix part number 012-0991-00). The TM5000 power module has a 24-pin **GPIB** connector on its rear panel (Figure 3-1). This connector has a D-type shell and conforms to IEEE Std 488.

You can also stack GPIB connectors.

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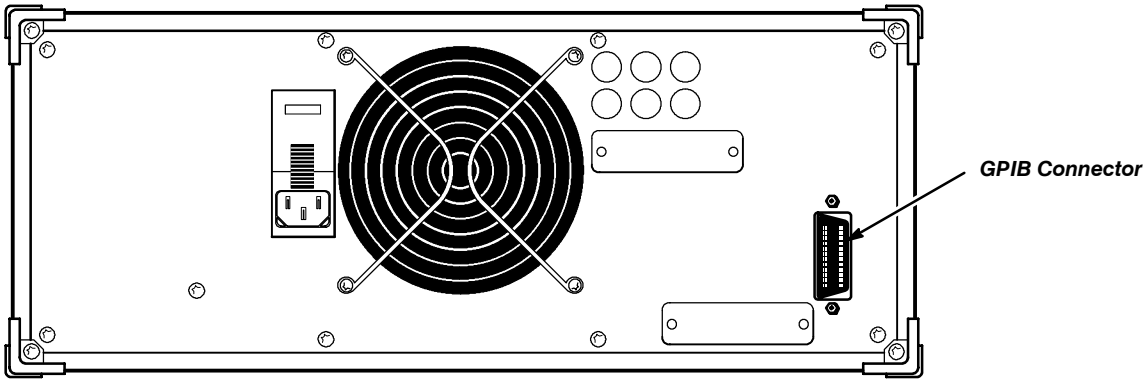


Figure 3-1: GPIB Connector Location

GPIB Requirements

Observe these rules when using your OA 5000 with a GPIB network:

- Each device on the bus must be assigned a unique device address; no two devices can share the same device address.
- Do not connect more than 15 devices to any one bus.
- Connect one device for every 6 feet (2 meters) of cable used.
- Do not use more than 65 feet (20 meters) of cable to connect devices to a bus.
- At least two-thirds of the devices on the network must be turned on while the network is operating.
- Connect the devices on the network in a star or linear configuration as shown in Figure 3-2. Do not use loop or parallel configurations.

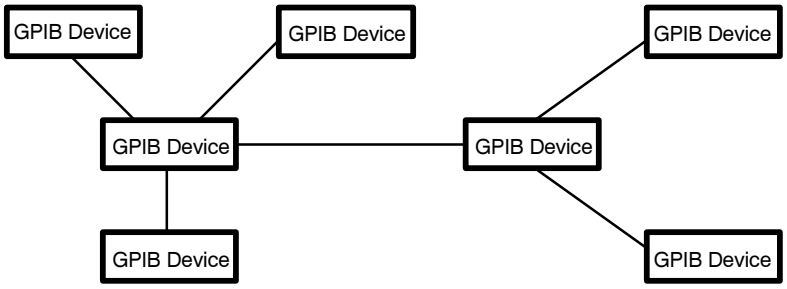


Figure 3-2: Typical GPIB Network Configurations

Appendix C, Interface Specifications, gives additional information on the OA 5000 GPIB configuration.

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Setting the GPIB Address

Once you have connected the OA 5000 through the GPIB interface, you need to set its GPIB address to allow it to communicate through the interface.

To set the GPIB address:

- ☐ **Step 1:** Press the **ADDR (SET)** button so that it is lighted. The **ATTENUATION** display will change to read **Addr** and the GPIB address will be displayed in the **WAVELENGTH** display.
- ☐ **Step 2:** Use either the **COARSE** or **FINE** knobs to change the address.
- ☐ **Step 3:** When the address is set, press the **ADDR (SET)** button again to enter the change of address.

Once you have set the address, you can control the OA 5000 through the GPIB interface.

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Command Syntax

You can control the OA 5000 through the GPIB using a large group of commands and queries. This section describes the syntax these commands and queries use and the conventions the OA 5000 uses to process them. The commands and queries themselves are listed in the section entitled Commands.

You transmit commands to the OA 5000 using the enhanced American Standard Code for Information Interchange (ASCII) character encoding. Appendix C includes a chart of the ASCII character set.

This manual uses Backus-Naur Form (BNF) notation and syntax diagrams to describe commands and queries. The syntax diagrams follow the notations and conventions of the ANSI/IEEE Std 488.2-1987, section 7.2.

This manual uses the following BNF symbols listed in Table 3-1.

Table 3-1: BNF Symbols and Meanings

Symbol	Meaning
< >	Defined element
::=	Is Defined As
|	Exclusive OR
{ }	Group; one element is required
[ ]	Optional; can be omitted
. . .	Previous element(s) may be repeated
( )	Comment

Clearing the OA 5000

You can stop any query or process by using the Device Clear (DCL) GPIB interface message.

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Command and Query Structure

Commands consist of set commands and query commands (usually simply called commands and queries). Commands modify instrument settings or tell the OA 5000 to take a specific action. Queries cause the OA 5000 to return information about its status.

Most commands have both a set form and a query form. The query form of the command is the same as the set form but with a question mark on the end. For example, the set command `ATT:DB` has a query form `ATT:DB?`. Not all commands have both a set and query form; some commands are set only and some are query only.

A command message is a command or query name, followed by any information the OA 5000 needs to execute the command or query. Command messages consist of three different element types, defined in Table 3-2 and shown in the example in Figure 3-3.

Table 3-2: Command Message Elements

Symbol	Meaning
`<Header>`	The basic command name. If the header ends with a question mark, the command is a query. The header may begin with a colon (:) character; if the command is concatenated with other commands the beginning colon is required. The beginning colon can never be used with command headers beginning with star (*).
`<Mnemonic>`	A header sub-function. Some command headers have only one mnemonic. If a command header has multiple mnemonics, they are always separated from each other by a colon (:) character.
`<Argument>`	A quantity, quality, restriction, or limit associated with the header. Not all commands have an argument, while other commands have multiple arguments. Arguments are separated from the header by one or more space characters. Arguments are separated from each other by a `<Separator>`, defined below.
`<Separator>`	A separator between arguments of multiple-argument commands. The separator can be a single comma, or it may optionally have white space characters before and after the comma.

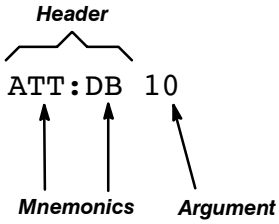


Figure 3-3: Command Message Elements

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Commands

Commands cause the OA 5000 to perform a specific function or change one of its settings. Commands have the structure:

- `[:]<Header>[<Space><Argument>[<Separator><Argument>]...]`

Queries

Queries cause the OA 5000 to return information about its status or settings. Queries have the structure:

- `[:]<Header>?`
- `[:]<Header>?[<Space><Argument>[<Separator><Argument>]...]`

You may use only a part of the header in a query command. When you do this, the instrument returns information about all the possible mnemonics that you have left unspecified. For example, `ATT:DB?` returns the current setting in absolute dB units, while `ATT?` returns the setting in absolute units and units relative to the reference.

Headers in Query Responses

You can control whether or not headers are returned by the OA 5000 as part of the query response. Use the `HEADER` command to control this feature. If header is on, command headers are returned as part of the query, and the query response is formatted as a valid set command. When header is off, only the values are sent back in the response, which may be easier to parse and to extract the information. Table 3-3 shows the difference in responses.

Table 3-3: Comparison of Header On and Off Responses

Query	Header Off Response	Header On Response
`DISP?`	`DB`	`:DISP DB`
`ATT:DB?`	`32.53`	`:ATT:DB 32.53`

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Command Entry

- Enter commands in upper or lower case.
- Precede any command with blank characters. Blank characters include any combination of the ASCII control characters 00 through 09 and 0B through 20 hexadecimal (0 through 9 and 11 through 32 decimal).
- The OA 5000 ignores commands consisting of any combination of blank characters, carriage returns, and line feeds.

Abbreviating Commands

Many OA 5000 commands can be abbreviated. These abbreviations are shown in capitals in the command's listing in the Commands section. For example, the command `DISPlay` can be entered simply as `DISP` or `display`.

If you use the `HEADER` command to have command headers included as part of query responses, you can further control whether the returned headers are abbreviated or are full-length. The `VERBOSE` command lets you control this.

Concatenating Commands

You can concatenate any combination of set commands and queries using a semicolon (;). The OA 5000 executes concatenated commands in the order received. Concatenating commands is useful when you want to avoid events generated by conflicting settings — see Conflicts on page 3–40.

When concatenating commands and queries you must follow these rules:

3. Completely different headers must be separated by both a semicolon and by the beginning colon on all commands but the first. For example, the commands `ATT:DB 15` and `DISABLE OFF` would be concatenated into a single command:

   ```
   ATT:DB 15;:DIS OFF
   ```

4. Never precede a star (*) command with a colon:

   ```
   ATT:DB 10;*OPC
   ```

5. When you concatenate queries, the responses to all the queries are concatenated into a single response message. For example, if the display mode is dB and the attenuator is 20 dB, the concatenated query

   ```
   DISP?;:ATT:DB?
   ```

   will return either `DISP DB;:ATT:DB 20` if Header is set to on, or `DB;20` if Header is set to off.

6. Set commands and queries may be concatenated in the same message. For example:

   ```
   ATT:DB 15;DISP DB;DIS?;:ADJ?
   ```


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is a valid message that sets the attenuation to 15 dB, the display mode to dB, and responds with the disable status and the adjusting status. Concatenated commands and queries are executed in the order received.

Here are some invalid concatenations:

- `DISPLAY DBR;ATT:DBR 5`
  no colon before `ATT`
- `ATT:MIN;:*OPC`
  extra colon before a star (*) command

Message Terminators

This manual uses <EOI> (End or Identify) to represent a message terminator.

Symbol	Meaning
<EOI>	Message terminator

If you use a GPIB network, <EOI> can be the IEEE Std 488 EOI interface symbol or LF (line feed). When using GPIB, the OA 5000 always accepts the EOI interface symbol as an input message terminator.

The end-of-message terminator may be either the END message (EOI asserted concurrently with the last data byte), the ASCII code for line feed (LF) sent as the last data byte, or both.

The end-of message terminator should not immediately follow a semicolon (;).

The OA 5000 always terminates responses to queries with linefeed and EOI asserted.

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Argument Types

The argument of a command may be in one of several forms. The individual descriptions of each command tell which argument types to use with that command.

Block Arguments

One OA 5000 command utilizes a block argument form:

Symbol	Meaning
<Block>	A block of data bytes, defined below
<NZDig>	A non-zero digit character, in the range 1 – 9
<Dig>	A digit character, in the range 0 – 9
<DChar>	A character with the binary equivalent of 0 through FF hexadecimal (0 through 255 decimal)

The block argument is in the following format:

- <Block> ::= #<NZDig><Dig>[<Dig>. . .][<DChar>. . .]

<NZDig> specifies the number of <Dig> elements that follow. Taken together, the <Dig> elements form a decimal integer that specifies how many <DChar> elements follow.

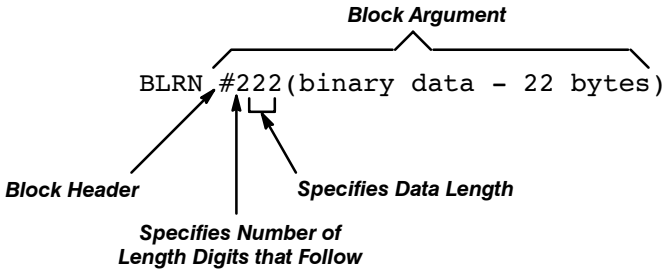


Figure 3-4: Block Argument Example

The block argument can also take the following format:

- <Block> ::= #0[<DChar>. . .]<EOI>

Under IEEE Std 488.2 this is also a valid form for block arguments. If this form is used, the last byte of the block must have EOI asserted. Consequently, this must be the last or only command. Although the OA 5000 accepts this format, it will never respond to a query with this format.

Numeric Arguments

Many OA 5000 commands require numeric arguments. This manual represents these arguments as follows:

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Symbol	Meaning
<NR1>	Signed integer value
<NR2>	Floating point value without an exponent
<NR3>	Floating point value with an exponent
<NRf>	Flexible numeric argument {NR1 | NR2 | NR3}. A suffix composed of a multiplier (letter exponent) and units may be used as an alternate to NR3. For example, this numeric type would let you use “10nm” as an alternate to “10E−9m”

Syntax Diagrams

The syntax diagrams in this manual use the following symbols and notation:

- Circles and ovals contain literal elements that must be sent exactly as shown. Command and query names are abbreviated to the minimum required spelling.
- Boxes contain the defined elements described earlier in this section, such as <NRf> or <QString>.
- Arrows connect the elements and show the allowed paths through the diagram. This also shows the different orders in which the elements can be sent. Parallel paths show that one and only one of the paths must be taken. A path around a group of elements shows that those elements are optional. Loops show elements that can be repeated.

Figure 3-5 shows the structure of a few typical syntax diagrams.

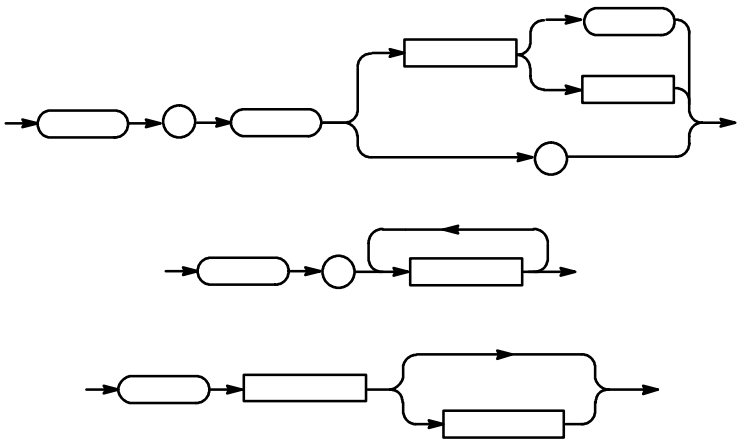


Figure 3-5: Typical Syntax Diagrams

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Commands

OA 5000 commands fall into two main groups: Common Commands and Device Commands. The commands follow Tektronix Standard Codes and Formats 1991.

Most of these commands can be used either as set commands or queries. However, some commands can only be used to set: these have the words “No Query Form” included with the command name. Other commands can only be used to query: these have a question mark appended to the header, and include the words “Query Only” in the command name.

Headers, mnemonics, and arguments are usually spelled out fully in text, with the minimum required spelling shown in upper case. For example, to use the command RECall you must enter at least REC. The examples in this manual use the abbreviated forms.

Common Commands and Queries

Several commands and queries used with the OA 5000 are common to all devices on the GPIB. These commands and queries are defined by IEEE Std 488.2-1987 and Tektronix Standard Codes and Formats 1991 as useful across all instruments in a GPIB system.

Table 3-4 lists the Common Commands supported by the OA 5000. Complete descriptions of these commands appear in an alphabetical listing of commands later in this section.

Table 3-4: Commands Common to All GPIB Devices and Supported by the OA 5000 Series

Header	Full Command Name
ALLev?	All Events
BLRN	Binary Device Setup
*CAL?[1]	Instrument Self Calibration
*CLS	Clear Status
DESE	Device Event Status Enable
*ESE	Standard Event Status Enable
*ESR?	Standard Event Status Register
EVENT?	Event
EVMSG?	Event Message
EVQTy?	Number of Events in Queue

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Table 3-4: Commands Common to All GPIB Devices and Supported by the OA 5000 Series (Cont.)

Header	Full Command Name
FACTory	Set to Factory Defaults
HEADer	Header
*IDN?	Identification
*LRN?	Learn Device Setup
*OPC	Operation Complete
*PSC	Power-On Status Clear
*RST	Reset
*SRE	Service Request Enable
*STB?	Read Status Byte
*TST?	Self-Test
VERBOSE	Verbose
*WAI	Wait To Continue

[1]*CAL? always returns 0.

Device Commands and Queries

Table 3-5 lists the device commands, queries, and command parameters that are specific to the OA 5000. Complete descriptions of these commands appear in the alphabetical listing of commands that immediately follows this table.

Table 3-5: OA 5000 Device Commands and Parameters

Header	Full Command Name
ADJusting?	Attenuator Adjusting
ATTen	Attenuation
ATTen:DB	Attenuation in Absolute Terms
ATTen:DBR	Attenuation with Reference Value
ATTen:MIN	Minimum Attenuation
DISable	Light Shutter Status
DISPlay	Front Panel Display Mode
RECall	Recall Attenuation Setting

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Table 3-5: OA 5000 Device Commands and Parameters (Cont.)

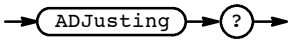
Header	Full Command Name
REFerence	Reference
STORe1|2	Store Attenuation
WAVelength	Wavelength

ADJusting? (Query Only)

The ADJusting? query returns the status of the attenuator. A 1 is returned if the attenuator is moving to some attenuation value. A 0 is returned if the attenuator is stationary.

Related Commands: *OPC, *WAI.

Syntax: `ADJusting?`



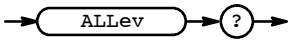
Examples: `ADJ?`
would return the string `":ADJUSTING 0"` or `":ADJUSTING 1"`.

ALLev? (Query Only)

The ALLev? query causes the OA 5000 to return all events and their messages. This query also removes the returned events from the Event Queue. The messages are separated by commas. Use the *ESR? query to enable the events to be returned. For a complete discussion of the use of these registers, see page 3–35. This command is similar to repeatedly sending EVMsg? queries to the OA 5000.

Related Commands: *CLS, DESE, *ESE, *ESR?, EVENT?, EVMsg?, EVQTY, *SRE, *STB?

Syntax: `ALLev?`



Returns: The event code and message in the following format:

```
<Event Code><Comma><QString>[<Event Code><Com-
ma><QString>...]
```


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```
<QString>::= <Message>;[<Command>]
```

<Command> is the command that caused the error and may be returned when a command error is detected by the OA 5000. As much of the command will be returned as possible without exceeding the 60 character limit of the <Message> and <Command> strings combined. The command string is right-justified.

Examples: `ALLev?`

might return the string `401,"Power on"` or `113,"Undefined header; unrecognized command-abc"`.

ATTenuation

ATTenuation can be used as both a query and as a command to set device parameters. ATTenuation has three parameters: DB, DBR, and MIN. Use the DB term to query or set attenuation in absolute terms relative to minimum attenuation. To query or set attenuation values relative to the REFerence value, use the DBR term. To set the attenuation to the minimum (0 dB), use the MIN term.

NOTE

Attenuation can be changed even if the light shutter is closed.

Related Commands: STORe, RECall.

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Syntax: `ATTen:DB?`

`ATTen:DBR?`

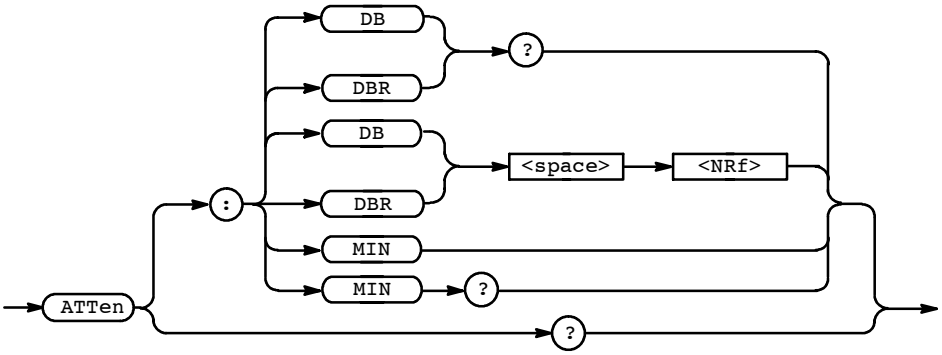
`ATTen:DB <NRf>`

`ATTen:DBR <NRf>`

`ATTen:MIN`

`ATTen:MIN?`

`ATTen?`



Arguments: If you make a query without an argument (for example, ATTen?), the response is the same as that for an ATTen:DB?; DBR? query.

Examples: `ATT:DB?`
returns the string
`:ATTEN:DB <present setting, absolute>`

`ATT:DBR?`
returns the string
`:ATTEN:DBR <present setting, minus REF>`

`ATT:MIN?`
returns the string
`:ATTEN:MIN <1 if at min, 0 otherwise>`

BLRN

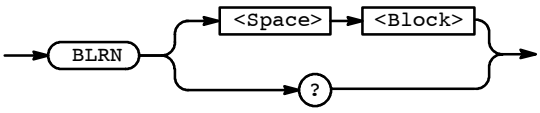
The query version of this command reads the instrument configuration in binary form. The command version configures the instrument binary data format. The configuration is 22 bytes long.

Related Commands: *LRN.

Syntax: `BLRN <Block>`

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BLRN?



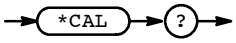
Examples: BLRN?
might return the response:
BLRN #222 <22 bytes of binary data>

*CAL? (Query Only)

This command performs no function in the OA 5000. It is included for compliance with IEEE Std 488.2.

Related Commands: N/A

Syntax: *CAL?



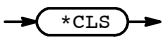
Examples: *CAL?
would return "0".

*CLS (No Query Form)

The *CLS (Clear Status) command clears the OA 5000 status data structures. This command also puts the OA 5000 in the Operation Complete Command Idle State and in the Operation Complete Query Idle State. While in these states the OA 5000 has nothing in its buffers and does not execute commands or queries.

Related Commands: DESE, *ESE, *ESR, EVENT?, EVMSG?,*SRE, *STB.

Syntax: *CLS



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The *CLS command clears

- the Event Queue,
- the Standard Event Status Register (SESR), and
- the Status Byte Register (except the MAV bit; see below).

If the *CLS command immediately follows an <EOI>, the Output Queue and MAV bit (Status Byte Register bit 4) are also cleared. MAV indicates information is in the output queue. DCL will clear the output queue and thus MAV. *CLS does not clear the output queue or MAV. (A complete discussion of these registers and bits and of event handling in general is on page 3–35.)

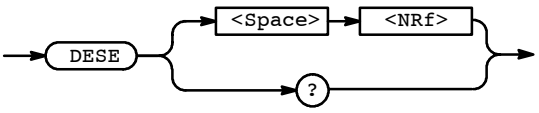
DESE

The DESE (Device Event Status Enable) command sets and queries the bits in the Device Event Status Enable Register (DESER). The DESER prevents events from being reported to the Standard Event Status Register (SESR) and from being entered into the Event Queue. For a complete discussion of the use of these registers, see page 3–35.

Related Commands: *CLS, *ESE, *ESR, EVENT?, EVMSG?, *SRE, *STB.

Syntax: DESE <NRf>

DESE?



Arguments: <NRf> is a value in the range from 0 to 255. The binary bits of the DESER are set according to this value. For example, DESE 209 sets the DESER to the binary value 11010001 (that is, the first bit in the register is set to 1, the second bit to 1, the third bit to 0, etc.).

The power-on default for DESER is all bits set if *PSC is 1. If *PSC is 0, the DESER maintains its value through a power cycle.

NOTE

Setting the DESER and the ESER to the same value allows only those codes to be entered into the Event Queue and summarized on the ESB bit (bit 5) of the Status Byte Register. Use the *ESE *command to set the ESER. A complete discussion of event handling is on page 3–35.*

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Examples: `DESE 209`

sets the DESER to binary 11010001, which enables the PON, URQ, EXE, and OPC bits.

`DESE?`

might return the string `:DESE 186`, showing that the DESER contains the binary value 10111010.

DISable

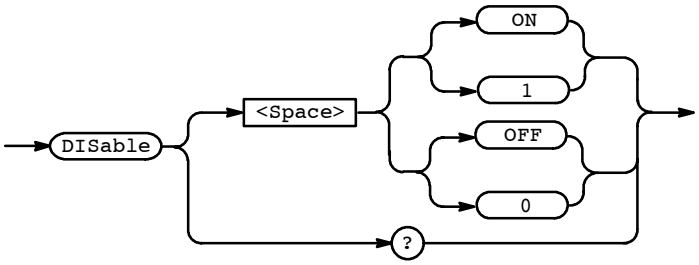
To query or set the status of the light shutter, use the DISable term. A DISable argument of 1, or ON, closes the light shutter and blocks all light through the fiber ports. A DISable argument of 0, or OFF, opens the shutter and allows light to pass through the fiber ports (light will be attenuated at the level specified by the ATTEN:DB or ATTEN:DBR terms).

Related Commands:

Syntax: `DISable {ON|1}`

`DISable {OFF|0}`

`Disable?`



Examples: `DIS?`

returns the string

`DIS 0`

if the light shutter is not closed.

DISPlay

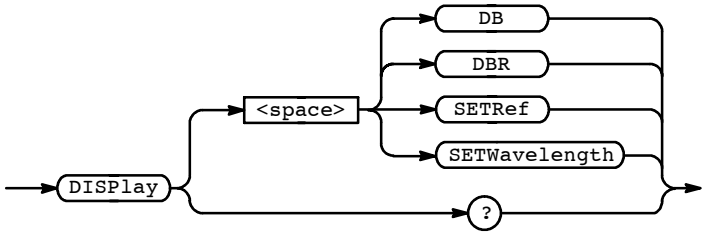
Use the DISPlay command to set the front panel display mode. The DB and DBRef parameters specify display of attenuation relative to minimum attenuation and relative to the reference values respectively. The SETRef and SETWavelength parameters put the front panel in a state which that the user to set the reference value and the wavelength via the front panel controls.

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Related Commands:

Syntax: `DISPlay {DB|DBR|SETRef|SETWavelength}`

`DISPlay?`



Examples: `DISP?`

returns the string

`:DISP DB`

`DISP:SETRef`

Sets the front panel to the Set Reference mode (has the same effect as pressing the SET REF button on the front panel).

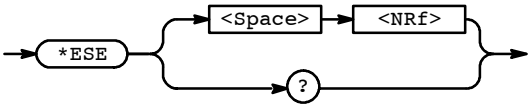
*ESE

The *ESE (Event Status Enable) command sets and queries the bits in the Event Status Enable Register (ESER). The ESER prevents events from being reported to the Status Byte Register (STB). For a complete discussion of the use of these registers, see page 3–35.

Related Commands: *CLS, DESE, *ESR, EVENT?, EVMSG? *SRE, *STB.

Syntax: `*ESE <NRf>`

`*ESE?`



Arguments: <NRf> is a value in the range from 0 through 255. The binary bits of the ESER are set according to this value.

The power-on default for ESER is 0 if *PSC is 1. If *PSC is 0, the ESER maintains its value through a power cycle.

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NOTE

Setting the DESER and the ESER to the same value allows only those codes to be entered into the Event Queue and summarized on the ESB bit (bit 5) of the Status Byte Register. Use the `DESE` *command to set the DESER. A complete discussion of event handling is on page 3–35.*

Examples: `*ESE 209`

sets the ESER to binary 11010001, which enables the PON, URQ, EXE, and OPC bits.

`*ESE?`

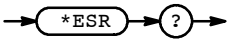
might return the string `*ESE 186`, showing that the ESER contains the binary value 10111010.

*ESR? (Query Only)

The *ESR? (Event Status Register) query returns the contents of the Standard Event Status Register (SESR). *ESR? also clears the SESR (since reading the SESR clears it). For a complete discussion of the use of these registers, see page 3–35.

Related Commands: ALLev?, *CLS, DESE, *ESE, EVENT?, EVMSG?, EVQTy?, *SRE, *STB.

Syntax: `*ESR?`



Examples: `*ESR?`

might return the value `213`, showing that the SESR contains binary 11010101.

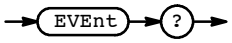
EVEnt? (Query Only)

The EVEnt? query returns from the Event Queue an event code that provides information about the results of the last *ESR? read. EVENT? also removes the returned value from the Event Queue. Note the the ALLev? command removes all pending events from the event queue and places them in the output queue. A complete discussion of event handling is on page 3–35.

Related Commands: ALLev?, *CLS, DESE, *ESE, *ESR?, EVMSG?, EVQty?, *SRE, *STB.

Syntax: `EVEnt?`

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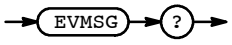
Examples: `EVEnt?`
might return the response `:EVENT 110`, showing that there was an error in a command header.

EVMSG? (Query Only)

The EVMSG? query removes from the Event Queue a single event code associated with the results of the last *ESR? read and returns the event code along with an explanatory message. A complete discussion of event handling is on page 3–35.

Related Commands: *CLS, DESE, *ESE, *ESR?, EVENT?, *SRE, *STB.

Syntax: `EVMSG?`



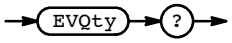
Examples: `EVMSG?`
might return the message `:EVMSG 110,"Command header error"`.

EVQty? (Query Only)

The EVQty? query returns returns the number of events associated with the last Standard Event Status Register read and thus the length of a subsequent response to an ALLev? query. The maximum number of event queue items is 32.

Related Commands: *CLS, DESE, *ESE, *ESR?, EVMSG?, *SRE, *STB.

Syntax: `EVQty?`



Examples: `EVQty?`
might return the response `:EVQTY 4`, showing that there are four events in the event queue.

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FACTORY (No Query Form)

The FACTORY command resets the OA 5000 to its factory default settings and purges stored settings.

NOTE

The FACTORY command can take 5 to 10 seconds to complete depending on attenuation settings.

Related Commands: DESE, *ESE, HEADER, *PSC, *RST, *SRE, VERBOSE.

Syntax: `FACTORY`



The FACTORY command does the following:

- Puts the OA 5000 in the Operation Complete Command Idle State.
- Puts the OA 5000 in the Operation Complete Query Idle State.
- Clears the Event Status Enable Register (equivalent to the command `*ESE 0`).
- Clears the Service Request Enable Register (equivalent to the command `*SRE 0`).
- Sets the Device Event Status Enable Register to all-enabled (equivalent to the command `DESE 255`).
- Sets the Power-on status clear flag to TRUE (equivalent to the command `*PSC 1`).
- Sets the Response Header Enable State to TRUE (equivalent to the command `HEADER 1`).
- Sets the Verbose Header State to TRUE (equivalent to the command `VERBOSE 1`).
- Sets the front panel as shown in Table 3-6.

Table 3-6: FACTORY Front Panel Settings

Front Panel Parameter	Setting
DISP:DB	
ATT:DB	0
REF	0
STORE1	0
STORE2	0

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Table 3-6: FACTORY Front Panel Settings (Cont.)

Front Panel Parameter	Setting
DISABLE	OFF
WAVELENGTH	1300

The FACTORY command does not alter the following items:

- The state of the GPIB (IEEE Std 488.2) interfaces.
- The selected GPIB address.
- Calibration data that affects device specifications.

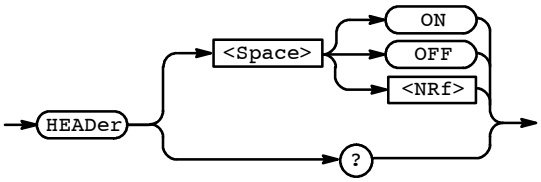
HEADer

The HEADer command sets and queries the Response Header Enable State that causes the OA 5000 to either include or omit headers on query responses. This command does not affect IEEE Std 488.2 Common Commands (those starting with an asterisk) or the *LRN? response.

Related Commands: VERBOSE.

Syntax: `HEADer { ON | OFF | <NRf> }`

`HEADer?`



Arguments: `ON` or `<NRf>` $\neq$ 0 sets the Response Header Enable State to TRUE. This causes the OA 5000 to include headers on applicable query responses. You can then use the query response as a command.

`OFF` or `<NRf>` = 0 sets the Response Header Enable State to FALSE. This causes the OA 5000 to omit headers on query responses, so that only the argument is returned.

Examples: `HEADER OFF`
causes the OA 5000 to omit headers from query responses.

`HEADER 1`
causes the OA 5000 to include headers on applicable query responses.

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HEADER?

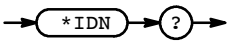
might return the value 1, showing that the Response Header Enable State is TRUE.

*IDN? (Query Only)

The *IDN? (Identification) query returns the OA 5000's unique identification code.

Related Commands: N/A

Syntax: *IDN?



The query response is an ASCII string separated into four fields by commas:

TEKTRONIX,OA5002,<serial number>,CF:91.1CN RM:<firmware version number>

Examples: *IDN?

might return the response

TEKTRONIX,OA5002,B010101,CF:91.1CN RM:1.5

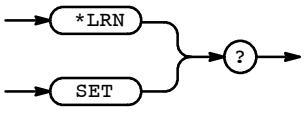
*LRN? or SET?

The *LRN? (Learn Device Setup) or SET? query returns a string listing the OA 5000's settings, except for calibration values. You can use this string to return the OA 5000 to the state it was in when you made the *LRN? query.

Related Commands: HEADER, VERBOSE.

Syntax: *LRN?

SET?



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NOTE

*The *LRN? query always returns a string with command headers, regardless of the setting of the HEADER command. This is because the returned string is intended to be able to be sent back to the OA 5000 as a command string. The VERBOSE command can still be used normally to specify whether the returned headers should be abbreviated or full length.*

Examples: `*LRN?`

might return the string:

```
:REFERENCE 0.00;:WAVELENGTH 1300;:ATTENUATION:DB
0.00;:DISPLAY DB;:DISABLE 0;:STORE1 0.00;:STORE2 0.00
```

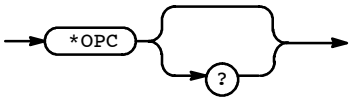
*OPC

The *OPC (Operation Complete) command generates the operation complete message in the Standard Event Status Register (SESR) when all pending operations finish. The *OPC? query places the ASCII character “1” into the Output Queue when all pending operations are finished. The *OPC? response is not available to read until all pending operations finish. For a complete discussion of the use of these registers and the output queue, see page 3–35.

Related Commands: *WAI, ADJusting?

Syntax: `*OPC`

`*OPC?`



*PSC

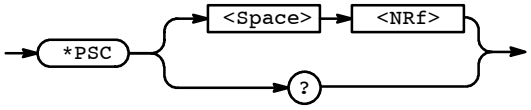
The *PSC (Power-On Status Clear) command sets and queries the power-on status flag that controls the automatic power-on handling of the DESER, SRER, and ESER registers. When PSC is TRUE, the DESER register is set to 255 and the SRER and ESER registers are set to 0 at power-on. When PSC is FALSE, the current values in the DESER, SRER, and ESER registers are preserved in non-volatile memory when power is shut off and restored at power-on. For a complete discussion of the use of these registers, see page 3–35.

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Related Commands: DESE, *ESE, *RST, *SRE.

Syntax: `*PSC <NRf>`

`*PSC?`



Arguments: <NRf> is a value in the range from −32767 to 32767.

<NRf> = 0 sets the power-on status clear flag to FALSE, and disables the power-on clear and allows the OA 5000 to assert SRQ after power-on.

<NRf> ≠ 0 sets the power-on status clear flag TRUE. Sending *PSC 1 therefore enables the power-on clear and prevents any SRQ assertion after power-on. Using an out-of-range value causes an execution error.

Examples: `*PSC 0`
sets the power-on status clear flag to FALSE.

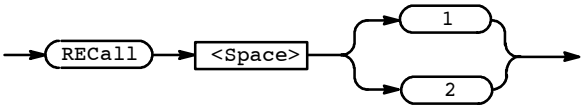
`*PSC?`
might return the value 1, showing that the power-on status clear flag is set to TRUE.

RECall (No Query Form)

The RECall command sets the attenuation of the instrument to either stored value 1 or 2.

Related Commands: STORe

Syntax: `RECall {1 | 2}`



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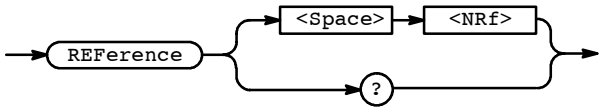
REFerence

This command reads and sets the reference used when displaying the attenuation in the ATT−REF mode. The units for command mode and responses is dB. Values smaller than 0.01 dB are rounded to the nearest one-hundredth dB. The REF value may not exceed ±99.99. The combination of the REF value and the ATTen value may not exceed ±99.99. For example, if the ATTen value is set to 30 dB and the REF value is set to −70 dB, the resultant ATT−REF value would be 100 dB, and an execution error event would result. The factory default for REF is 0.00 (dB).

Related Commands: N/A

Syntax: `REFerence <NRf>`

`REFerence?`



Arguments: <NRf> is a number that cannot exceed ±99.99.

Examples: `REF 45.00`
sets the REFerence value to 45.00 dB.

`REF?`
would return the string ″:REF 45.00″.

*RST (No Query Form)

The *RST (Reset) command returns the OA 5000 to a known set of instrument settings.

NOTE

*The *RST command can take 5 to 10 seconds to complete depending on attenuation settings.*

Related Commands: *PSC, FACTory.

Syntax: `*RST`



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*RST does the following:

- Puts the OA 5000 into the Operation Complete Command Idle State.
- Puts the OA 5000 into the Operation Complete Query Idle State.
- Returns the instrument settings to those listed on page 3–24.

The *RST command does not alter the following:

- The state of the IEEE Std 488.1 interface.
- The selected IEEE Std 488.1 address of the OA 5000.
- Calibration data that affects device specifications.
- The Output Queue.
- The Standard Status Register Enable setting.
- The Standard Event Status Enable setting.
- The Power-on status clear flag setting.
- HEADer and VERBose settings.

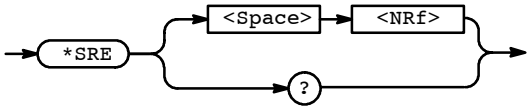
*SRE

The *SRE (Service Request Enable) command sets and queries the bits in the Service Request Enable Register (SRER). For a complete discussion of the use of these registers, see page 3–35.

Related Commands: ALLev?, *CLS, DESE, *ESE, *ESR, EVENT?, EVMSG?, EVQty?, *PSC, *STB.

Syntax: `*SRE <NRf>`

`*SRE?`



Arguments: `<NRf>` is a value in the range from 0 to 255. The binary bits of the SRER are set according to this value. Using an out-of-range value causes an execution error.

The power-on default for SRER is 0 if `*PSC` is 1. If `*PSC` is 0, the SRER maintains its value through a power cycle.

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Examples: `*SRE 48`

sets the bits in the SRER to 00110000 binary.

`*SRE?`

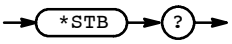
might return a value of 32, showing that the bits in the SRER have the binary value 00100000.

*STB? (Query Only)

The *STB? (Read Status Byte) query returns the Status Byte Register (SBR) using the Master Summary Status (MSS) bit. For a complete discussion of the use of these registers, see page 3–35.

Related Commands: ALLev?, *CLS, DESE, *ESE, *ESR, EVENT?, EVMSG?, EVQty?, *SRE.

Syntax: `*STB?`



Examples: `*STB?`

might return the value 96, showing that the STB contains the binary value 01100000.

STORe (Store Attenuation)

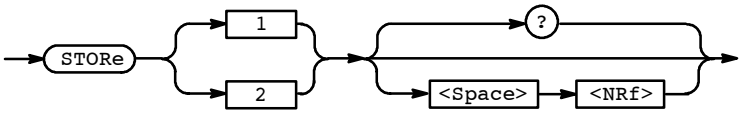
The STORe command sets or reads the value of stored positions 1 or 2. Using the command form (for example, STOR1) without a value specified stores the current attenuation in the specified location.

Related Commands: RECall

Syntax: `STORe{1|2}?`

`STORe{1|2}`

`STORe{1|2} <NRf>`



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Arguments: <NRf> specifies the attenuation value to be stored. The range for the attenuation value is 0 ≤ <NRf> ≤ 60.00. All attenuation values associated with the STORe command and query forms are in absolute dB and never include the REFERENCE value, even if the front panel display shows that the OA 5000 is set to ATT-REF mode.

Examples: STORE1?

returns the attenuation value stored in register 1, in the form:.

:STORE1 <NRf>

STORE1 20.00

sets the attenuation value in stored register 1 to 20.00 dB.

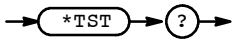
STORE2

stores the current attenuation value in stored register 2.

*TST? (Query Only)

The *TST? (Self-Test) query runs the OA 5000 internal self-test and reports the results. The self-test does not require operator interaction and does not create bus conditions that violate IEEE Std 488.1/488.2 standards. When complete, the OA 5000 returns to the state it was in just prior to the self-test. The test response is a value <NR1> as described in Table 3-7.

Syntax: *TST?



NOTE

*The *TST? query can take 5 seconds or more to respond.*

Table 3-7: Results from *TST?

<NR1>	Meaning
0	Test completed with no errors detected
101, 102	ROM checksum error
104	Non-volatile RAM is bad
115	System timer is bad
401	Calibration EEPROM is bad
410, 411	Calibration needed

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NOTE

*If an error is detected, *TST? stops and returns an error code and does not complete any remaining tests. It also places a device dependent event in the event queue.*

Examples: `*TST?`

might return the value `115`, indicating that the system timer is not working correctly.

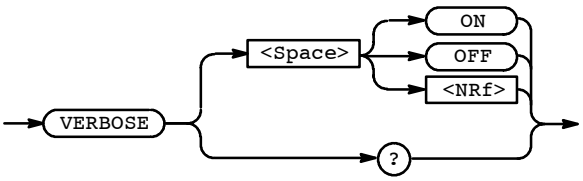
VERBOSE

The VERBOSE command sets and queries the Verbose Header State that controls the length of headers on query responses. This command does not affect IEEE Std 488.2 Common Commands (those starting with an asterisk).

Related Commands: HEADER, *LRN?.

Syntax: `VERBOSE { ON | OFF | <NRf> }`

`VERBOSE?`



Arguments: `ON` or `<NRf>` $\neq$ 0 sets the Verbose Header State TRUE, which returns full-length headers for applicable setting queries.

`OFF` or `<NRf>` = 0 sets the Verbose Header State FALSE, which returns minimum-length headers for applicable setting queries.

Examples: `VERBOSE ON`

sets the Verbose Header State TRUE.

`VERBOSE?`

might return the value `1`, showing that the Verbose Header State is TRUE.

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*WAI (No Query Form)

The *WAI (Wait) command prevents the OA 5000 from executing further commands or queries until all pending operations finish.

Related Commands: *OPC, ADJusting?.

Syntax: `*WAI`



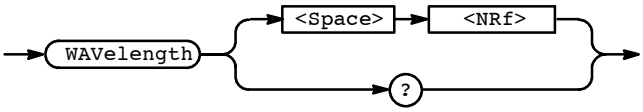
WAVelength

This commands set or queries the wavelength used by the instrument when determining the equivalent attenuator positioning for a given attenuation.

Related Commands: N/A

Syntax: `WAVelength <NRf>`

`WAVelength?`



Arguments: The valid range for the wavelength argument is 600 nm to 1700 nm. Default units are always in nanometers with N (for nano or 1E−09) and U (for micro or 1E−06) accepted as multipliers; M (for meters) is also an acceptable term (see examples below).

Examples: `WAV?`

returns the value of wavelength to which the OA 5000 is set. An example response is:

:WAVELENGTH 1300

`WAV 1300`

sets the wavelength to 1300 nm.

`WAV 1300NM`

sets the wavelength to 1300 nm.

`WAV 1.3UM`

sets the wavelength to 1300 nm.

`WAV 1.3E-09M`

sets the wavelength to 1300 nm.

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Status and Events

The OA 5000 provides a status and event reporting system for the GPIB interfaces. This system informs you of certain significant events that occur within the OA 5000.

The OA 5000 status handling system consists of five 8-bit registers and two queues. This section describes these registers and components and explains how the event handling system operates.

Registers

The registers in the event handling system fall into two functional groups:

- The Standard Event Status Register (SESR) and the Status Byte Register (SBR) contain information about the status of the OA 5000. These registers are therefore called the Status Registers.
- The Device Event Status Enable Register (DESER), the Event Status Enable Register (ESER), and the Service Request Enable Register (SRER) determine whether selected types of events are reported to the Status Registers and the Event Queue. These three registers are called the Enable Registers.

Status Registers

The Standard Event Status Register (SESR) and the Status Byte Register (SBR) record certain types of events that may occur while the OA 5000 is in use. These registers are defined by IEEE Std 488.2-1987. Refer also to Figure 3-6 and Table 3-8.

Each bit in a Status Register records a particular type of event, such as an execution error or service request. When an event of a given type occurs, the bit that represents that type of event is set to a value of one. (You can disable bits so that they ignore events and remain at zero; see the Enable Registers section on page 3–37.) Reading the status registers tells you what types of events have occurred.

The Standard Event Status Register (SESR) — The SESR, shown in Figure 3-6, records eight types of events that can occur within the OA 5000. Use the *ESR? query to read the SESR register. Reading the register clears the bits of the register so that the register can accumulate information about new events.

7	6	5	4	3	2	1	0
PON	URQ	CME	EXE	DDE	QYE	RQC	OPC

Figure 3-6: The Standard Event Status Register (SESR)

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Table 3-8: SESR Bit Functions

Bit	Function
7 (MSB)	**PON** (Power On). Shows that the OA 5000 was powered on.
6	**URQ** (User Request). Shows that the Remote button was pressed.
5	**CME** (Command Error). Shows that an error occurred while the OA 5000 was parsing a command or query. Command error messages are listed in Table 3-11 on page 3–41.
4	**EXE** (Execution Error). Shows that an error occurred while the OA 5000 was executing a command or query. Execution error messages are listed in Table 3-12 on page 3–42.
3	**DDE** (Device Error). Shows that a device error occurred. Device error messages are listed in Table 3-13 on page 3–43.
2	**QYE** (Query Error). Shows that either an attempt was made to read the Output Queue when no data was present or pending, or that data in the Output Queue was lost.
1	**RQC** (Request Control). Not used.
0 (LSB)	**OPC** (Operation Complete). Shows that the operation is complete. This bit is set by the `*OPC` command.

The Status Byte Register (SBR) — shown in Figure 3-7, records whether output is available in the Output Queue, whether the OA 5000 requests service, and whether the SESR has recorded any events.

Use a Serial Poll or the *STB? query to read the contents of the SBR. Refer to Table 3-9. The bits in the SBR are set and cleared depending on the contents of the SESR, the Event Status Enable Register (ESER), and the Output Queue. (When you use a Serial Poll to obtain the SBR, bit 6 is the RQS bit. When you use the *STB? query to obtain the SBR, bit 6 is the MSS bit.)

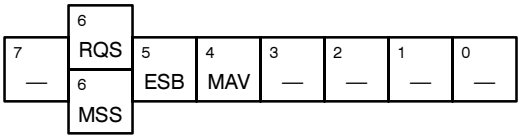


Figure 3-7: The Status Byte Register (SBR)

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Table 3-9: SBR Bit Functions

Bit	Function
7 (MSB)	Not used (always 0).
6	**RQS** (Request Service), obtained from a serial poll. Shows that the OA 5000 requests service from the GPIB controller.
6	**MSS** (Master Status Summary), obtained from *STB? query. Summarizes the ESB and MAV bits in the SBR.
5	**ESB** (Event Status Bit). Shows that status is enabled and present in the SESR.
4	**MAV** (Message Available). Shows that output is available in the Output Queue.
3–0	Not used (always 0).

Enable Registers

The DESER, ESER, and SRER allow you to select which events are reported to the Status Registers and the Event Queue. Each Enable Register acts as a filter to a Status Register (the DESER also acts as a filter to the Event Queue), and can prevent information from being recorded in the register or queue.

Each bit in an Enable Register corresponds to a bit in the Status Register it controls. In order for an event to be reported to its bit in the Status Register, the corresponding bit in the Enable Register must be set to one. If the bit in the Enable Register is set to zero, the event is not recorded.

The bits in the Enable Registers are set using various commands. The Enable Registers and the commands used to set them are described below.

The Device Event Status Enable Register (DESER) — is shown in Figure 3-8. This register controls which types of events are reported to the SESR and the Event Queue. The bits in the DESER correspond to those in the SESR, as described earlier.

Use the DESE command to enable and disable the bits in the DESER. Use the DESE? query to read the DESER.

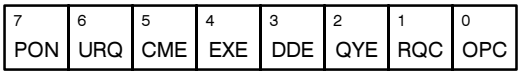


Figure 3-8: The Device Event Status Enable Register (DESER)

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The Event Status Enable Register (ESER) — is shown in Figure 3-9. It controls which types of events are summarized by the Event Status Bit (ESB) in the SBR.

Use the *ESE command to set the bits in the ESER, and use the *ESE? query to read it.

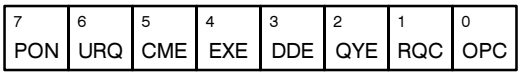


Figure 3-9: The Event Status Enable Register (ESER)

The Service Request Enable Register (SRER) — is shown in Figure 3-10. It controls which bits in the SBR generate a Service Request and are summarized by the Master Status Summary (MSS) bit.

Use the *SRE command to set the SRER. Use the SRE? query to read it. The RQS bit remains set to one until either the Status Byte Register is read with a Serial Poll or the MSS bit changes back to a zero.

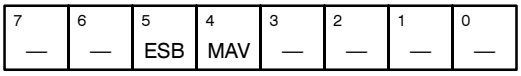


Figure 3-10: The Service Request Enable Register (SRER)

The Enable Registers and the *PSC Command

The *PSC command controls the contents of the Enable Registers at power-on. Sending *PSC 1 sets the Enable Registers at power on as follows:

- DESER 255 (equivalent to a DESe 255 command)
- ESER 0 (equivalent to an *ESE 0 command)
- SRER 0 (equivalent to an *SRE command)

Sending *PSC 0 lets the Enable Registers maintain their values in nonvolatile memory through a power cycle.

NOTE

*To enable the PON (Power On) event to generate a Service Request, send *PSC 0, use the DESe and *ESE commands to enable PON in the DESER and ESER, and use the *SRE command to enable bit 5 in the SRER. Subsequent power-on cycles will generate a Service Request.*

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Queues

The OA 5000 status and event reporting system contains two queues: the Output Queue and the Event Queue.

The Output Queue

The Output Queue stores up to 8000 bytes of a query response while it is waiting to be output. The Output Queue is emptied each time a new command or query message is received, so that any query response must be read before the next command or query is sent, or responses to earlier queries will be lost, and an error may result.

The Event Queue

The Event Queue stores detailed information on up to 32 events. If more than 32 events stack up in the Event Queue, the 32nd event is replaced by event code 350, “Too many events.”

Read the Event Queue with either the EVENT? query (which returns only the event number) or with the EVMSG? query (which returns the event number and a text description of the event). Reading an event removes it from the queue.

Before reading an event from the Event Queue, you must use the *ESR? query to read the summary of that event from the SESR. This makes the events summarized by the *ESR? read available to the EVENT? and EVMSG? queries, and empties the SESR.

Reading the SESR erases any events that were summarized by a previous *ESR? read but not read from the Event Queue. Events that follow an *ESR? read are put in the Event Queue but are not available until *ESR? is used again.

Event Handling Sequence

Figure 3-11, on page 3–40, shows how to use the status and event handling system. In the explanation that follows, numbers in parentheses refer to numbers in Figure 3-11.

When an event occurs, a signal is sent to the DESER (1). If that type of event is enabled in the DESER (that is, if the bit for that event type is set to 1), the appropriate bit in the SESR is set to one and the event is recorded in the Event Queue (2). If the corresponding bit in the ESER is also enabled (3), then the ESB bit in the SBR is set to one (4).

When output is sent to the Output Queue, the MAV bit in the SBR is set to one (5).

When a bit in the SBR is set to one and the corresponding bit in the SRER is enabled (6), the MSS bit in the SBR is set to one and a service request is generated (7).

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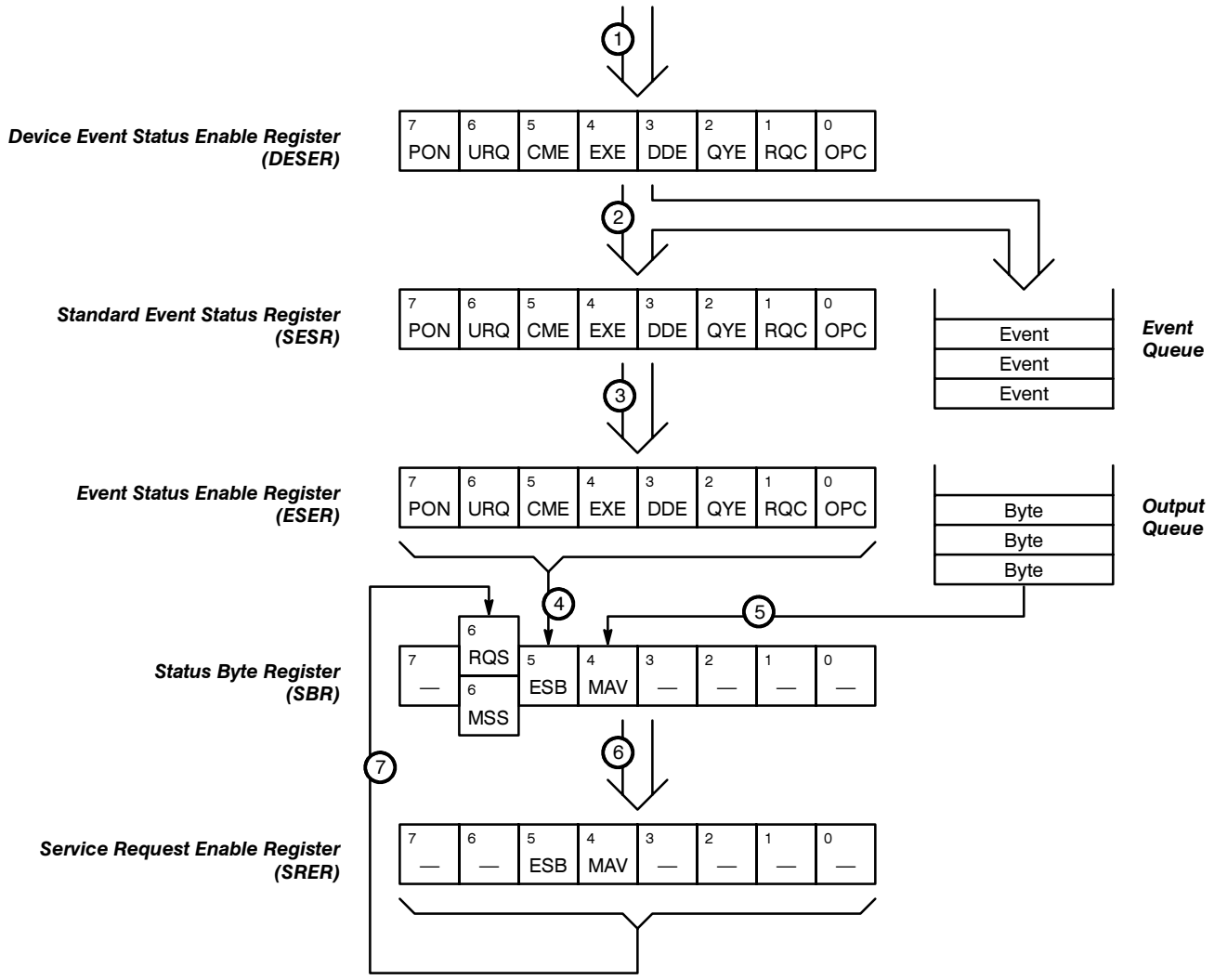


Figure 3-11: Status and Event Handling Process

Conflicts

Whenever a command is issued that results in a conflict, an event is generated on the EXE bit (bit 4).

You can avoid generating this event if you concatenate commands so that the conflict is resolved when the command is completed. For example, when setting the attenuator in DBR mode, always make sure that the REF command precedes the ATT:DBR command or an execution warning may result.

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Messages

Tables 3-10 through 3-15 list all the programming interface messages the OA 5000 generates in response to commands and queries.

For most messages, a secondary message from the OA 5000 gives more detail about the cause of the error or the meaning of the message. This message is part of the message string, and is separated from the main message by a semicolon.

Each message is the result of an event. Each type of event sets a specific bit in the SESR, and is controlled by the equivalent bit in the DESER. Thus, each message is associated with a specific SESR bit. In the message tables that follow, the associated SESR bit is specified in the table title, with exceptions noted with the error message text.

Table 3-10 shows the messages when the system has no events or status to report. These have no associated SESR bit.

Table 3-10: No Event Messages

Code	Message
0	No events to report – queue empty
1	No events to report – new events pending *ESR?

Table 3-11 shows the error messages generated by improper command syntax. Check that the command is properly formed and that it follows the rules in the Command Syntax chapter starting on page 3–5.

Table 3-11: Command Error Messages — CME Bit 5

Code	Message
100	Command error
101	Invalid character
102	Syntax error
103	Invalid message or unit separator
104	Data type error
105	GET not allowed
106	Invalid program data separator
108	Parameter not allowed
109	Missing parameter
110	Command header error
111	Header separator error
112	Program mnemonic too long

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Table 3-11: Command Error Messages — CME Bit 5 (Cont.)

Code	Message
113	Undefined header
118	Query not allowed
120	Numeric data error
121	Invalid character in number
123	Numeric overflow
124	Too many digits
128	Numeric data not allowed
130	Suffix error
131	Invalid suffix
134	Suffix too long
138	Suffix not allowed
140	Character data error
141	Invalid character data
144	Character data too long
148	Character data not allowed
150	String data error
151	Invalid string data
158	String data not allowed
160	Block data error
161	Invalid block data
168	Block data not allowed

Table 3-12 lists the execution errors that are detected during execution of a command. In these error messages, you should read “macro” as “alias.”

Table 3-12: Execution Error Messages — EXE Bit 4

Code	Message
200	Execution error
220	Parameter error
221	Settings in conflict

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Table 3-12: Execution Error Messages — EXE Bit 4 (Cont.)

Code	Message
222	Data out of range
223	Too much data

Table 3-13 lists the device errors that can occur during operation of the OA 5000. These errors may indicate that the OA 5000 needs repair.

Table 3-13: Device Error Messages — DDE Bit 3

Code	Message
300	Internal error
310	System error
313	Calibration memory lost
315	Configuration memory lost
350	Too many events (Does not set DDE bit)

Table 3-14 lists the system event messages. These messages are generated whenever certain system conditions occur.

Table 3-14: System Event Messages — QYE Bit 2

Code	Message
401	Power on – PON Bit 7
402	Operation complete – OPC Bit 0
403	User request – URQ Bit 6
410	Query INTERRUPTED
420	Query UNTERMINATED
430	Query DEADLOCKED
440	Query UNTERMINATED after indefinite response

Table 3-15 lists warning messages that do not interrupt the flow of command execution. These notify you that you might get unexpected results.

Table 3-15: Execution Warning Messages — EXE Bit 4

Code	Message
500	Execution warning

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Appendices

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Appendix A: Accessories

Some accessories are included with the OA 5000. If you wish to purchase optional accessories, or purchase additional standard accessories, see a Tektronix products catalog or contact your local Tektronix field representative.

Standard Accessories

- This manual, the *OA 5000 Optical Attenuator User Manual* (Tektronix part number 070-7612-03).
- The TM 5003 Power Module, Tektroninx part number 620-0057-00
- Two universal optical input and output connector kits, Tektronix part number 020-1885-00.
- Two blank plug-in panels, Tektronix part number 016-0195-05

Optional Accessories

The optional accessories appropriate for your instrument depend on which OA 5000 Optical Attenuator you purchased.

Optical Cables, Single Mode, 2 meter, 8/125 micron

- FC/PC to Diamond 2.5, Tektronix part number 174-1497-00.
- FC/PC to Diamond 3.5, Tektronix part number 174-1385-00.
- FC/PC to ST, Tektronix part number 174-1386-00.
- FC/PC to FC/PC, Tektronix part number 174-1387-00.
- FC/PC to Biconic, Tektronix part number 174-1388-00.

Optical Cables, Multimode, 2 meter, 62.5/140 micron

- FC/PC to Biconic, Tektronix part number 174-2323-00.
- FC/PC to SMA906, Tektronix part number 174-2324-00.
- FC/PC to FC/PC, Tektronix part number 174-2322-00.

Optical Cables, Multimode, 2 meter, 100/140 micron
(Note: at the time of publication, the 100 μm cables listed below did not utilize physical contact connectors)

- FC to SMA, Tektronix part number 174-0878-00.
- ST to SMA, Tektronix part number 174-0876-00.
- Diamond 2.5 to SMA, Tektronix part number 174-1303-00.

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Appendix B: Specifications

The performance characteristics described in this appendix (Tables A-1 through A-3) are valid under the following conditions:

- The instrument must have been calibrated at an ambient temperature between +20° C and +30° C.
- The instrument must have had a warm-up period of at least 20 minutes.
- All optical connections to the instrument are made using physical contact connectors. Tektronix offers limited selection of fiber optic jumper cables which utilize physical contact on the connector ends (for example: Tektronix part number 174-1387-00, see Appendix A).
- Both input and output connectors have been cleaned as described on page A–15.

Table A-1: Optical Characteristics

Characteristic	Specification	
Wavelength Range	OA 5002	1100 – 1600 nm
	OA 5012/22/32	750 – 1600 nm
Input		
OA 5002	Single Mode Fiber	
OA 5012	50 μm Multimode Fiber	
OA 5022	62.5 μm Multimode Fiber	
OA 5032	100 μm Multimode Fiber	
Insertion Loss		
750 – 1100 nm	≤ 4.0 dB (OA 5012/22/32 only)	
1100–1350 nm	≤ 2.0 dB	
1350–1600 nm	≤ 2.5 dB	
Return Loss		
OA 5002	≤ –45 dB	
OA 5012/5022/5032	≤ –25 dB	
Attenuation Range		
OA 5002		
1100 – 1350 nm	≥ 60 dB (calibrated, 0.01 dB step size)	
1350–1600 nm	≥ 50 dB (calibrated, 0.01 dB step size)	
OA 5012/22/32		
750–1350 nm	≥ 60 dB (calibrated, 0.01 dB step size)	
1350–1600 nm	≥ 50 dB (calibrated, 0.01 dB step size)	
Maximum Attenuation		
OA 5002/5012/5022	≥ 100 dB (shutter activated)	
OA 5032	≥ 90 dB (shutter activated)	
Repeatability	± 0.05 dB	

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Table A-1: Optical Characteristics (Cont.)

Characteristic	Specification
Linearity	± 0.1 dB max (typically ± 0.05 dB)
Accuracy OA 5002	
1310 ± 20 nm	≤ ± 0.15 dB (typically ≤ ± 0.05 dB)
1550 ± 20 nm	≤ ± 0.15 dB (0 to 40 dB) (typically ≤ ± 0.05 dB) ≤ ± 0.20 dB (≥ 40 dB)
All other wavelengths	Typically ≤ ±0.25 dB
OA 5012/5022/5032	
850 ± 20 nm	≤ ± 0.20 dB (typically ≤ ± 0.05 dB)
1310 ± 20 nm	≤ ± 0.20 dB (typically ≤ ± 0.05 dB)
1550 ± 20 nm	≤ ± 0.20 dB (typically ≤ ± 0.05 dB)
All other wavelengths	Typically ≤ ± 0.25 dB

Table A-2: Mechanical Characteristics

Characteristic	Specification
Net Weight	1.3 kg (2.86 lb.)
External Dimensions	
Height	14.0 cm (5.5 in.)
Width	23.4 cm (9.2 in.)
Length	44.4 cm (17.4 in.)

Table A-3: Environmental Performance

Characteristic	Specification
Temperature	
Operating	0° C to +50° C (32° F to 122° F)
Nonoperating (storage)	−40° C to +70° C (−40° F to 160° F) (Meets MIL−T−28800D, class 5.)
Altitude	
Operating	4.6 km (15,000 ft.)
Nonoperating	15 km (50,000 feet) (Exceeds MIL−T−28800D, class 5.)

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Table A-3: Environmental Performance (cont.)

Characteristic	Specification
Humidity	
Operating and Nonoperating	95% RH: 11° C to 30° C (52° F to 86° F) 75% RH: 11° C to 40° C (52° F to 104° F) 45% RH: 11° C to 50° C (52° F to 122° F) (Exceeds MIL−T−28800D, Class 5, noncondensing)
Vibration[1]	0.38 mm (0.015 in.) p-p, 5 Hz to 55 Hz, 75 minutes. Meets MIL−T−28800D, Class 5, when installed in qualified power modules[2].

[1] Requires retainer clip
[2] Refer to TM5000 Power Module specifications
[3] Without power module

Shock[1]	30 g's, (1/2 sine), 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks. Meets MIL−T−28800D, Class 5, when installed in qualified power modules.
Bench Handling[3]	12 drops from 45°, 4 in. or equilibrium, whichever occurs first. Meets MIL−T−28800D, Class 5, when installed in qualified power modules[2], and IEC 348 (Electronic measuring apparatus).
Packaged Product Vibration and Shock[1]	The packaged product qualifies under the National Safe Transit Association's Preshipment Test Procedures, Project 1A−B−1 and 1A−B−2.
Electrical Discharge	8 kV maximum discharge applied to operating instrument from an ESD source per IEC 801−2 (150 Ω/150 pF)

[1] Requires retainer clip
[2] Refer to TM5000 Power Module specifications
[3] Without power module

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Appendix C: Interface Specifications

This appendix describes details of the remote interface of the Optical Attenuator, that is, the GPIB. Normally, you will not need this information to use the OA 5000, but the information is useful when connecting to controllers of unusual configuration.

This appendix also contains general information that pertains to programming with both interfaces. This information includes a chart of the ASCII character set and a list of reserved words.

Interface Messages

Table A-4 shows the standard interface messages that are supported by the OA 5000.

Table A-4: OA 5000 Standard Interface Messages

Message	GPIB
DCL	Yes
GET	No
GTL	Yes
LLO	Yes
PPC	No
PPD	No
PPE	No
PPU	No
SDC	Yes
SPD	Yes
SPE	Yes
UNL	Yes
UNT	Yes
Listen Addresses	Yes
Talk Addresses	Yes

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Character Set (ASCII Chart)

Table A-5 shows the character set used for all messages to and from the OA 5000. This is identical to standard ASCII.

Table A-5: The ASCII Character Set

	0	1	2	3	4	5	6	7
0	NUL 0	DLE 16	space 32	0 48	@ 64	P 80	‘ 96	p 112
1	SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113
2	STX 2	DC2 18	” 34	2 50	B 66	R 82	b 98	r 114
3	ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115
4	EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116
5	ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117
6	ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118
7	BEL 7	ETB 23	’ 39	7 55	G 71	W 87	g 103	w 119
8	BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120
9	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
A	LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122
B	VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123
C	FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	| 124
D	CR 13	GS 29	– 45	= 61	M 77	] 93	m 109	} 125
E	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126
F	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	rubout 127

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GPIB Function Subsets

The OA 5000 supports many GPIB function subsets, as listed below. Some of the listings describe subsets that the OA 5000 does not support.

- SH1 (Source Handshake). The OA 5000 can transmit multi-line messages across the GPIB.
- AH1 (Acceptor Handshake). The OA 5000 can receive multi-line messages across the GPIB.
- T6 (Talker). The OA 5000 becomes a talker when its talk address is sent with the ATN (Attention) line asserted. It ceases to be a talker when another device's talk address is sent with ATN asserted. The OA 5000 has no talk-only capability.
- L4 (Listener). The OA 5000 becomes a listener when its listen address is sent with the ATN (Attention) line asserted. The OA 5000 does not have listen-only capability.
- SRQ (Service Request). The OA 5000 asserts the SRQ (Service Request) line to notify the controller when it requires service.
- RL1 (Remote/Local). The OA 5000 responds to both the GTL (Go To Local) and LLO (Local Lock Out) interface messages.
- PPO (Parallel Poll). The OA 5000 has no parallel poll capability. It does not respond to the following interface messages: PPC, PPD, PPE, and PPU. The OA 5000 does not send out a status message when the ATN (Attention) and EOI (End of Instruction) lines are asserted simultaneously.
- DCL (Device Clear). When acting as a listener, the OA 5000 responds to the DCL (Device Clear) and SDC (Selected Device Clear) interface messages.
- DT (Device Trigger). The OA 5000 does not respond to the GET (Group Execute Trigger) interface message.
- C0 (Controller). The OA 5000 cannot control other devices.
- E2 (Electrical). The OA 5000 uses tri-state buffers to provide optimal high-speed data transfer.

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Appendix D: Using the *OPC Query/Command

When you are using the OA 5000 in an automated test environment, it is important that you be aware of the finite times for certain OA 5000 commands to complete. For example: suppose you develop an automated test in which the attenuator is adjusted over the GPIB bus via the ATT:DB n command. After each adjustment by the attenuator, you might then make an automated reading from an optical power meter (such as the Tektronix OCP 5502). In such a sequence, it is important that you not initiate the reading from the optical power meter before the attenuator has completed all adjustments and has come to a stable position (that is, the ATT ADJ indicator is no longer illuminated).

Below is an example that illustrates the use of GPIB commands and queries utilizing the *OPC? query/command. In this example, queries to other instruments (such as the power meter in this example) are not made until all of the OA 5000's pending operations have completed.

Example: A command is sent to the OA 5000 to change attenuation to 45 dB; the command is immediately followed by an *OPC? query across the GPIB bus to the same OA 5000.

1. Write to the OA 5000 GPIB address: **ATT:DB 45.00; *OPC?**
2. Read from OA 5000 GPIB address: **1**

Depending on the previous attenuation setting of the OA 5000, several seconds may be required before the **ATT:DB** command is completed and the *OPC? produces a "1" in the OA 5000 GPIB output queue. After the *OPC? query is sent to the OA 5000, the programmer should immediately attempt a GPIB read instruction from the controller. The programmer's controller should wait until the OA 5000 finishes all adjustments and the *OPC query provides a "1" to be read.

NOTE

It is important that you remember to set the time-out of the controller's GPIB READ instruction to be greater than the longest time possible for the OA 5000 to make any adjustments (up to five seconds may be required to make large changes to attenuation settings).

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You can also have the OA 5000 set the OPC bit of the SESR by using the command form of *OPC instead of the query form. By setting the OPC bit to “1” via an *OPC command, an SRQ will be generated assuming the user has enabled the proper register bits.

- Advanced programmers can develop other methods to accomplish the set-and-wait-until-complete routine utilizing the event queues and status registers provided in the OA 5000.

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Appendix E: Packing for Shipment

If you ship the OA 5000, pack it in the original shipping carton and packing material. If the original packing material is not available, package the instrument as follows:

- ☐ **Step 1:** Obtain a corrugated cardboard shipping carton with inside dimensions at least 15 cm (6 in) taller, wider, and deeper than the OA 5000. The shipping carton must be constructed of cardboard with 375 pound test strength.
- ☐ **Step 2:** If you are shipping the OA 5000 to a Tektronix field office for repair, attach a tag to the OA 5000 showing the instrument owner and address, the name of the person to contact about the instrument, the instrument type, and the serial number.
- ☐ **Step 3:** Wrap the OA 5000 with polyethelene sheeting or equivalent material to protect the finish.
- ☐ **Step 4:** Cushion the OA 5000 in the shipping carton by tightly packing dunnage or urethane foam on all sides between the carton and the OA 5000. Allow 7.5 cm (3 in) on all sides, top, and bottom.
- ☐ **Step 5:** Seal the shipping carton with shipping tape or an industrial stapler.

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Appendix F: Maintenance

This appendix describes how to perform routine maintenance on the OA 5000 Series Optical Attenuators. There are no user-serviceable parts in the OA 5000. Should your instrument need service, contact your nearest Tektronix service representative.

The following maintenance procedures are discussed in this chapter.

- Cleaning the Optical Port
- Changing Optical Port Connectors

Cleaning the Optical Ports

If the OA 5000 performance appears degraded, the optical fiber and optical port may be dirty. Clean the fiber connector with a clean cloth. To clean an optical port, perform the following steps:

1. Turn the power supply off or pull the OA 5000 out of the power module.
2. Use a Phillips screwdriver to remove the four screws that secure the bulkhead connector to the front panel (see Figure A-1 on page A–16).
3. Gently pull the bulkhead out of the unit and unscrew the fiber connector. Be careful not to pull beyond the fiber slack. If there is insufficient slack or if you accidently push the disconnected fiber back into the instrument, then perform the following three steps:
   a. Using a flat-blade screwdriver, turn the securing screw on the right-side cover 90° counter-clockwise and remove the side cover (See Figure A-1).
   b. You will now have access to the optical fiber. Unscrew it from the bulkhead if necessary or push it back through the front panel.
   c. Reinstall the cover when finished. Turn the securing screw to lock the side cover.
4. Using a soft, lint-free cloth with a high-quality glass cleaner, clean the tip of the fiber cable.
5. If available, use low-pressure compressed air or canned air to blow any dirt out of the bulkhead connector. If compressed air is not available, then the bulkhead will have to be taken apart and cleaned. Refer to the Changing the Optical Port Connectors procedure, on page A–17, for information about bulkhead disassembly.
6. After cleaning the bulkhead, reconnect the fiber and install the bulkhead. Be sure to reinstall the dust cover chain.

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NOTE

To keep cleaning to a minimum, install the dust cover when no fiber is connected to the optical port.

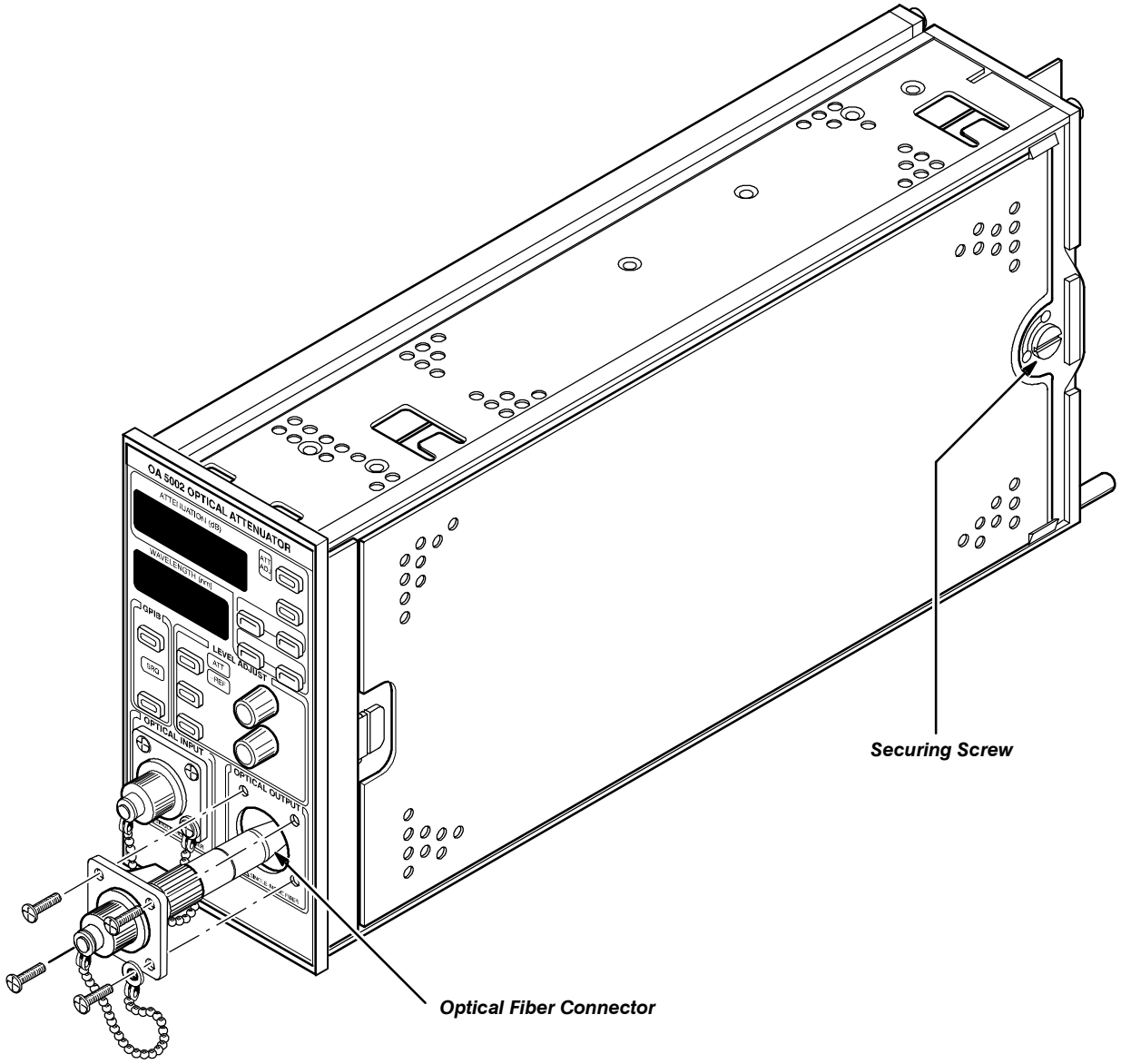


Figure A-1: Removing the Optical Bulkhead Connector

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Changing the Optical Port Connectors

The OA 5000 is shipped with the FC connector bulkhead and dust cover installed. If you wish to change to the ST, DIN 47256, or SC connectors, perform the following procedure.

1. Turn the power supply off first and then pull the OA 5000 out of the power module.
2. Use a Phillips screwdriver to remove the four screws that secure the bulkhead connector to the front panel (see Figure A-1).
3. Gently pull the bulkhead out of the unit and unscrew the fiber connector. Be careful not to pull beyond the fiber slack. If there is insufficient slack or if you accidently push the disconnected fiber back into the instrument, then perform the following three steps:
   a. Using a flat-blade screwdriver, turn the securing screw on the right-side cover 90° counter-clockwise and remove the side cover (See Figure A-1).
   b. You will now have access to the optical fiber. Unscrew it from the bulkhead if necessary or push it back through the front panel.
   c. Reinstall the side cover when finished. Turn the securing screw to lock the side cover.
4. Disassemble the bulkhead as shown in Figures A-2 through A-5.

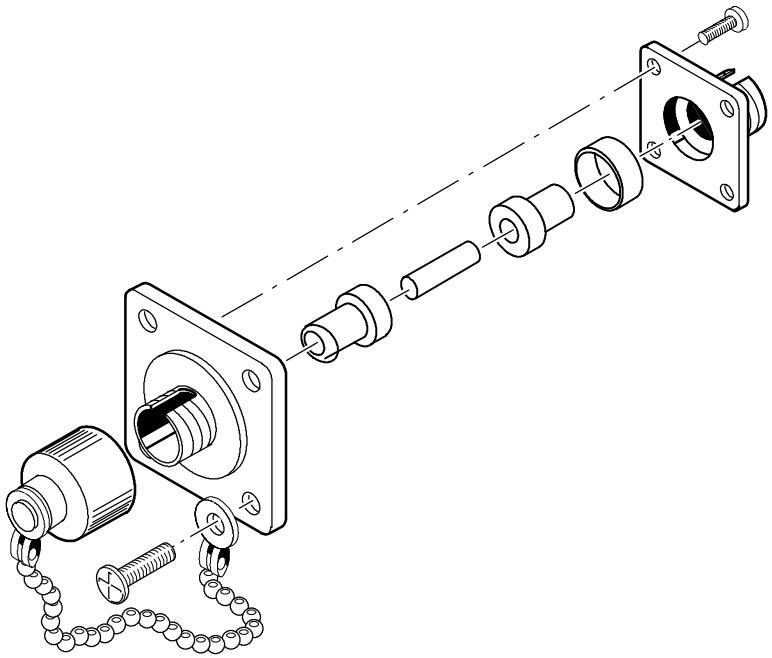


Figure A-2: FC Optical Bulkhead Assembly

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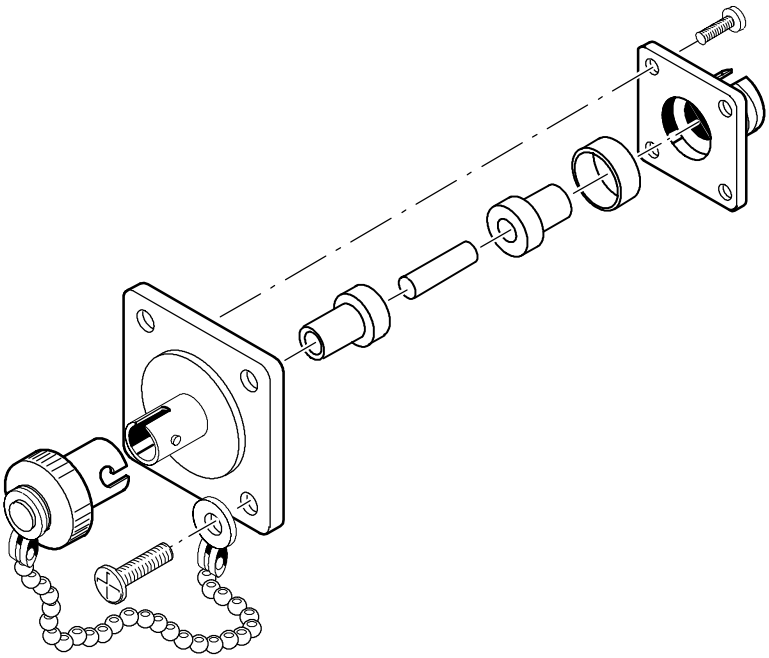


Figure A-3: ST Optical Bulkhead Assembly

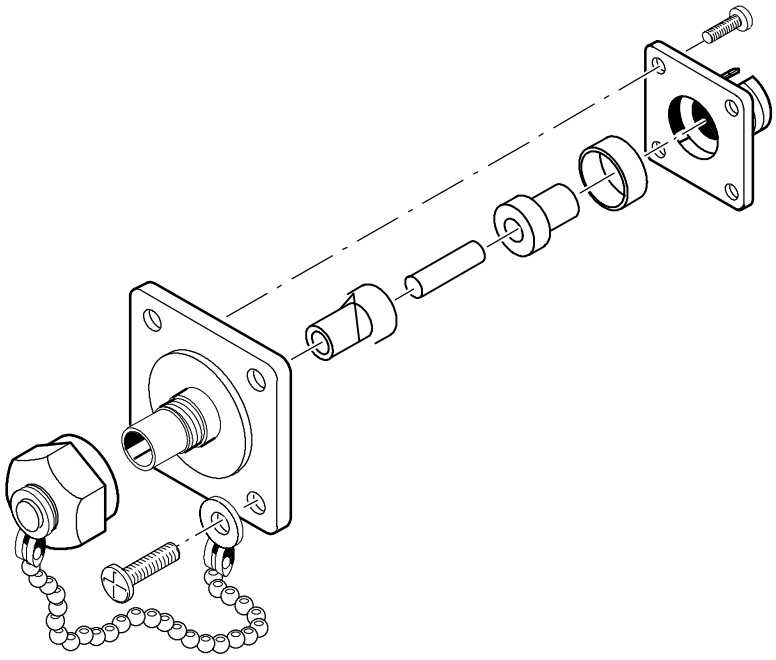


Figure A-4: DIN 47256 Optical Bulkhead Assembly

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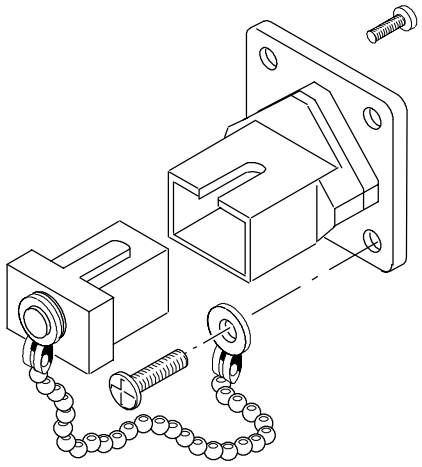


Figure A-5: SC Optical Bulkhead Assembly

5. Replace the current bulkhead with the one you wish to use and re-assemble.
6. Installation is the reverse of steps 1 through 3.

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Appendix F: Maintenance

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Appendix G: Product Verification

Equipment List

Refer to Table 4-1 for a list of the equipment required to verify the performance of your OA 5000 Series instrument.

Table 4-1: Equipment Required for Performance Verification

Description	Minimum Use Specifications	Recommendation
850 nm Laser source	CW, 850 ±20 nm, actual wavelength known within ±1 nm; >500 μW into 50/125 μm fiber; <0.02 dB/minute stability[1]	Fotec S785
1310 nm Laser source	CW, 1310 ±20 nm, actual wavelength known within ±1 nm; >1 mW into SM fiber; <0.02 dB/minute stability[1]	Advantest Q81211/Q8221
1550 nm Laser source	CW, 1550 ±20 nm, actual wavelength known within ±1 nm; >500 μW into SM fiber; <0.02 dB/minute stability[1]	Advantest Q81212/Q8221
(1310 and 1550 nm) Optical power meter with long wavelength sensor	±(0.025 dB + 0.3 pW) linearity, −90 to +3 dBm; noise (p−p) < 0.5 pW; accepts 9/125 to 100/140 μm fiber	Agilent/HP 81532A/8153A
(850 nm) Optical power meter with short wavelength sensor	±(0.025 dB + 0.3 pW) linearity, −90 to +3 dBm; accepts 9/125 to 100/140 μm fiber	Agilent/HP 81530A/8153A
OA 5002, Optical input fiber, 1 each	50 m long, if available, or a fiber as short as 1 m can be used; 9/125 μm, FC/PC to FC/PC[2]	
OA 5002, Optical output fiber, 1 each	1 to 5 m long, 9/125 μm, FC/PC to FC/PC[2]	Tektronix 174-1387-00
OA 5012, Optical input and output fiber	1 to 5 m long, 50/125 μm, FC/PC to FC/PC[2]	

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Table 4-1: Equipment Required for Performance Verification

Description	Minimum Use Specifications	Recommendation
OA 5022, Optical input and output fiber	1 to 5 m long, 62.5/125 μm, FC/PC to FC/PC[2]	Tektronix 174-2322-00
OA 5032, Optical input and output fiber	1 to 5 m long, 100/140 μm, FC/PC to FC/PC[2]	
FC/FC adapter	Female to female	Tektronix 131-6252-00

[1] Laser should have short coherence length (<1 m if possible) and multiple longitudinal modes to minimize effects of polarization and reflection. If a DFB or tunable laser is used, it should have a coherence control feature and optionally a polarization scrambler.

[2] The fiber specifications assume that adapters on the test equipment and the DUT (device under test) are FC/PC. Alternative adapters can be used with appropriate changes in the fiber connectors.

Power Up

☐ **Step 1:** Insert the OA 5000 into a powered-down Tektronix TM 5000 series Mainframe power supply.

- Make certain that the OA 5000 is securely latched into the mainframe.

☐ **Step 2:** Turn the TM 5000 mainframe power on (via mainframe's power switch)

☐ **Step 3:** A few seconds are required after mainframe power-up before the OA 5000 displays become lit.

- Once the displays become active, all LEDs and digital segments will be lit for a couple of seconds; any segment which does not light up during this time is either defective, burnt out, or is not connected.
- This test can be invoked anytime after power up by pushing and holding the **ADDR(SET)** button.

☐ **Step 4:** The wavelength, attenuation, and display mode will power-up at whatever values existed before the previous power-down; if the instrument is being powered on for the first time the settings will be at their factory default values (see manual for these default values).

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Display Modes

☐ **Step 1:** Push the **MODE** button until ATT is backlit and -REF is not backlit (these LEDs are green);

- The **MODE** button itself should now be backlit (this LED is red).

☐ **Step 2:** Push the **MIN ATT** button; this will cause the instrument to adjust to zero dB (a few seconds may be needed to complete the adjustment if the previous setting was non-zero).

- The **MIN ATT** button should itself be backlit
- **0.00** should be displayed in the ATTENUATION(dB) display

☐ **Step 3:** Push the **SET REF** button.

- The **SET REF** button should now be backlit; the **MODE** button should not be backlit.
- Check that the WAVELENGTH(nm) display is showing "**SEt**".

☐ **Step 4:** Adjust the numerical value displayed in the ATTENUATION(dB) display by manipulating the **COARSE** and **FINE** knobs; the coarse knob should increment or decrement the value by 1 dB per detent; the fine knob should increment or decrement the value by 0.01 dB.

- Set the display to read "**–10.00**"
- Push the **SET REF** button again; the button will then be unlit and the **MODE** should now be lit with the ATT only backlit.

☐ **Step 5:** Push the **MODE** once again.

- Check to see that "ATT" and "–REF" are both backlit
- The ATTENUATION(dB) display should now read "**10.00**" (This is because ATT=0.00;REF=–10.00; hence, the result ATT–REF=0–(–10.00)=10.00)
- Pushing the **MODE** button repeatedly will toggle the "–REF" backlighting on and off and the displayed attenuation will toggle between "**0.00**" and "**10.00**"
- Set the **MODE** so that the "ATT" only is backlit before going to the next step.

☐ **Step 6:** Push the **WAVELENGTH** button once.

- The ATTENUATION(dB) display should read "**SEt**" and the **WAVELENGTH** button will be backlit.
- The **COARSE** and **FINE** knobs increment or decrement the value displayed in the WAVELENGTH(nm) display; the coarse knob should increment or decrement the wavelength value by 10 nm; the fine knob should increment or decrement the value by 1 nm.

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- Set the WAVELENGTH(nm) display to read "**1300**".
- Push the **WAVELENGTH** button once more; check that the button is no longer backlit and that the **MODE** button is backlit. (After exiting the wavelength mode, the instrument may require a second or two to recalculate calibration for the new wavelength; the ATT ADJ light next to the ATTENUATION(dB) display will briefly be backlit to indicate this.)

GPIB Address Setting

☐ **Step 1:** Push the **ADDR(SET)** button once.

- The button should become backlit, the ATTENUATION display should read "**Addr**", and the WAVELENGTH display should show a number from **0** to **30** or the word "**OFF**".

☐ **Step 2:** While in this mode, the coarse and fine knobs should increment or decrement the displayed address value by 1; adjust the value, using the knobs, to the address desired.

- Check that when the value is adjusted above "**30**" that the word "**OFF**" appears.

☐ **Step 3:** Push the **ADDR(SET)** button once again while the desired address is being displayed; the display mode should return to whatever state the instrument was in before pushing the **ADDR(SET)** button.

NOTE

The address of the instrument is not actually updated until the ADDR (SET) mode is exited.

Attenuation Range

☐ **Step 1:** Enter the Wavelength set mode for the OA 5000 by pushing the **WAVELENGTH** button so that the display reads "**SEt**".

☐ **Step 2:** Using the knobs, adjust the wavelength to read 1350 nm.

☐ **Step 3:** Exit the Wavelength Set mode by pushing the **WAVELENGTH** button again; the instrument will require a second to prepare the new calibration tables (as indicated by the ATT ADJ briefly lighting up).

☐ **Step 4:** Adjust the OA 5000 such that the display mode is showing attenuation in dB with the ATT indicator lit and the –REF indicator not lit.

☐ **Step 5:** Using the knobs, increase the level of attenuation (turn the coarse knob clockwise); keep increasing the level until the value reaches a maximum level and no longer increases. This value should exceed 60.00 dB.

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☐ **Step 6:** Enter the Wavelength set mode for the OA 5000 by pushing the **WAVELENGTH** button so that the top display reads "**SEt**".

☐ **Step 7:** Using the knobs, adjust the wavelength to read 1600 nm.

☐ **Step 8:** Exit the Wavelength Set mode by pushing the **WAVELENGTH** button again; the instrument will require a second to prepare the new calibration tables (as indicated by the ATT ADJ briefly lighting up).

☐ **Step 9:** Adjust the OA 5000 such that the display mode is showing attenuation in dB with the ATT indicator lit and the −REF indicator not lit.

☐ **Step 10:** Using the knobs, increase the level of attenuation (turn the coarse knob clockwise); keep increasing the level until the value reaches a maximum level and no longer increases. This value should exceed 50.00 dB.

Shutter Attenuation and the DISABLE button

☐ **Step 1:** Set the optical power meter as follows (operating instructions are for HP8153A):

- Select the long wavelength power sensor.
- Wavelength: actual wavelength (±1 nm) of 1310 nm laser
- Averaging: 1 s
  Toggle the Mode key to display **PARAM**, and then press the **Param** key to display T and set T to 1 s.
- Displayed units: W (watts)

☐ **Step 2:** Cover the sensor input and zero the power meter.

☐ **Step 3:** Connect the 1310 nm laser to the OA 5000 input using the input fiber specified in the equipment table.

☐ **Step 4:** Connect the OA 5000 output to the sensor using the output fiber specified in the equipment table.

NOTE

For the OA 5012, OA 5022, and OA 5032 the input fiber may have a smaller core diameter than the one specified, as long as the laser can couple into the fiber. For these models, the output fiber may have a larger core diameter than the one specified, up to 100 μm.

☐ **Step 5:** Set the OA 5000:

- Wavelength: actual wavelength (±1 nm) of 1310 nm laser
- Attenuation: 0 dB
- Disable: off (unlit)

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☐ **Step 6:** Set the laser to **CW** (unmodulated) mode, and set the laser power level (if adjustable) to maximum, but not more than 2 mW. Turn on the laser. The power meter reading should be at least 500 μW.

☐ **Step 7:** Set the power meter to dB relative (press the **dB** key), and set the dB reference (press **Disp–>Ref**). The power meter should read 0.0 dB ±0.1 dB.

☐ **Step 8:** Set the OA 5000 **DISABLE** button to on (lit).

NOTE

The measurement in step 9 is near the noise floor of the power meter, so it may be necessary to repeat the meter zero (with sensor capped) and the measurement several times to get a valid result. If an average reading lower than about −97 dB can't be obtained (except for the OA 5032), it might be due to noise in the sensor. A laser with a higher power output might be needed to improve the range of the measurement.

☐ **Step 9:** Verify the OA 5000 shutter attenuation by checking that average (not peak) value of the power meter reading is −100 dB or lower (more negative), except −90 dB or lower for OA 5032.

1310 nm: Insertion Loss, Attenuation Accuracy, and Repeatability

NOTE

Stable light levels must be maintained throughout the insertion loss, attenuation accuracy, and repeatability tests. Use only fiber optic connectors that are clean and in good condition. It may be necessary to remove the OA 5000 bulkhead connectors and clean the OA 5000 connectors and fibers (see Appendix F).

☐ **Step 1:** Leave the fibers connected to the 1310 nm laser and the long wavelength sensor. Disconnect the fibers from the OA 5000, and connect the fibers together using an FC/FC adapter.

☐ **Step 2:** Assure that the wavelength displays of the OA 5000 and the power meter are set to the actual wavelength (not the nominal wavelength) of the laser, within ±1 nm.

☐ **Step 3:** Set the power meter to **W** (watts) mode. The reading should be 700 μW or more. Set the power meter to dB relative mode (press the **dB** key), and set the dB reference (**Disp–>Ref**). The power meter should read 0.0 dB ±0.1 dB.

☐ **Step 4:** Disconnect the fibers from the FC/FC adapter, and connect them to the OA 5000.

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☐ **Step 5:** Set the OA 5000 attenuation to 0 dB, and the **DISABLE** button off (unlit).

☐ **Step 6:** The power meter reading is the insertion loss of the OA 5000. Check that the power meter reading is −2.0 dB or higher (more positive).

NOTE

During the remaining steps, do not disturb the connections and fibers.

☐ **Step 7:** Set the dB reference (**Disp−>Ref**) at the power meter. The power meter reading should be 0.00 dB within ±0.01 dB.

☐ **Step 8:** Set the OA 5000 to each of the settings in the table below, and check that the power meter reads within the listed accuracy limits. At 30 dB, note the reading.

☐ **Step 9:** Set the OA 5000 to 0 dB. Check that the power meter reads 0.00 dB within the repeatability specification (±0.05 dB).

☐ **Step 10:** Set the OA 5000 to 30 dB. Check that the power meter reads the same as in step 8, within the repeatability specification (±0.05 dB).

☐ **Step 11:** If the readings in steps 9 and 10 do not meet the repeatability specifications, check the connections, and repeat steps 7 to 10.

Table 4-2: Attenuation Accuracy at 1310 nm

	OA 5002	**OA 5012 / OA 5022 / OA 5032**
Attenuation setting (dB)	**Tolerance Limits (dB)**	**Tolerance Limits (dB)**
10	−10.15 to −9.85	−10.20 to −9.80
20	−20.15 to −19.85	−20.20 to −19.80
30	−30.15 to −29.85	−30.20 to −29.80
40	−40.15 to −39.85	−40.20 to −39.80
50	−50.15 to −49.85	−50.20 to −49.80
60	−60.15 to −59.85	−60.20 to −59.80

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1550 nm: Insertion Loss, Attenuation Accuracy, and Repeatability

☐ **Step 1:** Disconnect the fibers from the OA 5000 and 1310 nm laser. Connect the 1550 nm laser to the input fiber and the long wavelength sensor to the output fiber. Connect the fibers together using an FC/FC adapter. Set the laser to **CW** (unmodulated) mode, and set the laser power level (if adjustable) to maximum, but not more than 2 mW. Turn on the laser.

☐ **Step 2:** Set the wavelength displays of the OA 5000 and the power meter to the actual wavelength (not the nominal wavelength) of the laser, within ±1 nm.

☐ **Step 3:** Set the power meter to **W** (watts) mode. The reading should be at least 400 μW. Set the power meter to dB relative (**dB** key) mode, and set the dB reference (**Disp–>Ref**). The power meter should read 0.0 dB ±0.1 dB.

☐ **Step 4:** Disconnect the fibers from the FC/FC adapter, and connect them to the OA 5000.

☐ **Step 5:** Set the OA 5000 attenuation to 0 dB, and the **DISABLE** button off (unlit).

☐ **Step 6:** The power meter reading is the insertion loss of the OA 5000. Check that the power meter reading is −2.5 dB or higher (more positive).

NOTE

During the remaining steps, do not disturb the connections and fibers.

☐ **Step 7:** Set the dB reference (**Disp–>Ref**) at the power meter. The power meter reading should be 0.00 dB within ±0.01 dB.

☐ **Step 8:** Set the OA 5000 to each of the settings in the table below, and check that the power meter reads within the listed accuracy limits. At 30 dB, note the reading.

☐ **Step 9:** Set the OA 5000 to 0 dB. Check that the power meter reads 0.00 dB within the repeatability specification (±0.05 dB).

☐ **Step 10:** Set the OA 5000 to 30 dB. Check that the power meter reads the same as in step 8, within the repeatability specification (±0.05 dB).

☐ **Step 11:** If the readings in steps 9 and 10 do not meet the repeatability specifications, check the connections, and repeat steps 7 to 10.

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Table 4-3: Attenuation Accuracy at 1550 nm

	OA 5002	OA 5012 / OA 5022 / OA 5032
Attenuation setting (dB)	**Tolerance Limits (dB)**	**Tolerance Limits (dB)**
10	−10.15 to −9.85	−10.20 to −9.80
20	−20.15 to −19.85	−20.20 to −19.80
30	−30.15 to −29.85	−30.20 to −29.80
40	−40.15 to −39.85	−40.20 to −39.80
50	−50.20 to −49.80	−50.20 to −49.80

850 nm (except OA 5002): Insertion Loss, Attenuation Accuracy, and Repeatability

☐ **Step 1:** Disconnect the fibers from the OA 5000, 1550 nm laser, and long wavelength sensor. Connect the 850 nm laser to the input fiber and the short wavelength sensor to the output fiber. Connect the fibers together using an FC/FC adapter. Set the laser to **CW** (unmodulated) mode, and set the laser power level (if adjustable) to maximum, but not more than 2 mW. Turn on the laser.

☐ **Step 2:** At the power meter, select the short wavelength sensor. Set the wavelength displays of the OA 5000 and the power meter to the actual wavelength (not the nominal wavelength) of the laser, within ±1 nm.

☐ **Step 3:** Set the power meter to W (watts) mode. The reading should be at least 400 μW. Set the power meter to dB relative (**dB** key) mode, and set the dB reference (**Disp−>Ref**). The power meter should read 0.0 dB ±0.1 dB.

☐ **Step 4:** Disconnect the fibers from the FC/FC adapter, and connect them to the OA 5000.

☐ **Step 5:** Set the OA 5000 attenuation to 0 dB, and the **DISABLE** button to off (unlit).

☐ **Step 6:** The power meter reading is the insertion loss of the OA 5000. Check that the power meter reading is −4.0 dB or higher (more positive).

NOTE

During the remaining steps, do not disturb the connections and fibers.

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☐ **Step 7:** Set the dB reference (**Disp–>Ref**) at the power meter. The power meter reading should be 0.00 dB within ±0.01 dB.

☐ **Step 8:** Set the OA 5000 to each of the settings in the table below, and check that the power meter reads within the listed accuracy limits. At 30 db, note the reading.

☐ **Step 9:** Set the OA 5000 to 0 dB. Check that the power meter reads 0.00 dB within the repeatability specification (±0.05 dB).

☐ **Step 10:** Set the OA 5000 to 30 dB. Check that the power meter reads the same as in step 8, within the repeatability specification (±0.05 dB).

☐ **Step 11:** If the readings in steps 9 and 10 do not meet the repeatability specifications, check the connections, and repeat steps 7 to 10.

Table 4-4: Attenuation Accuracy at 850 nm

	OA 5012 / OA 5022 / OA 5032
Attenuation setting (dB)	**Tolerance Limits (dB)**
10	−10.20 to −9.80
20	−20.20 to −19.80
30	−30.20 to −29.80
40	−40.20 to −39.80
50	−50.20 to −49.80
60	−60.20 to −59.80

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Appendix H: Replaceable Parts

This chapter contains a list of the components that are replaceable for the OA 5002, OA 5012, OA 5022, and OA 5032 Optical Attenuators. As described below, use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc. service center or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If a part you order has been replaced with a different or improved part, your local Tektronix service center or representative will contact you concerning any change in the part number.

Change information, if any, is located at the rear of this manual.

Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find the all the information you need for ordering replacement parts.

Item Names

In the Replaceable Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, U.S. Federal Cataloging Handbook H6-1 can be used where possible.

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Indentation System

This parts list is indented to show the relationship between items. The following example is of the indentation system used in the Description column:

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
(END ATTACHING PARTS)
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
(END ATTACHING PARTS)
Parts of Detail Part
Attaching parts for Parts of Detail Part
(END ATTACHING PARTS)

Attaching parts always appear at the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. Attaching parts must be purchased separately, unless otherwise specified.

Abbreviations

Abbreviations conform to American National Standards Institute (ANSI) standard Y1.1

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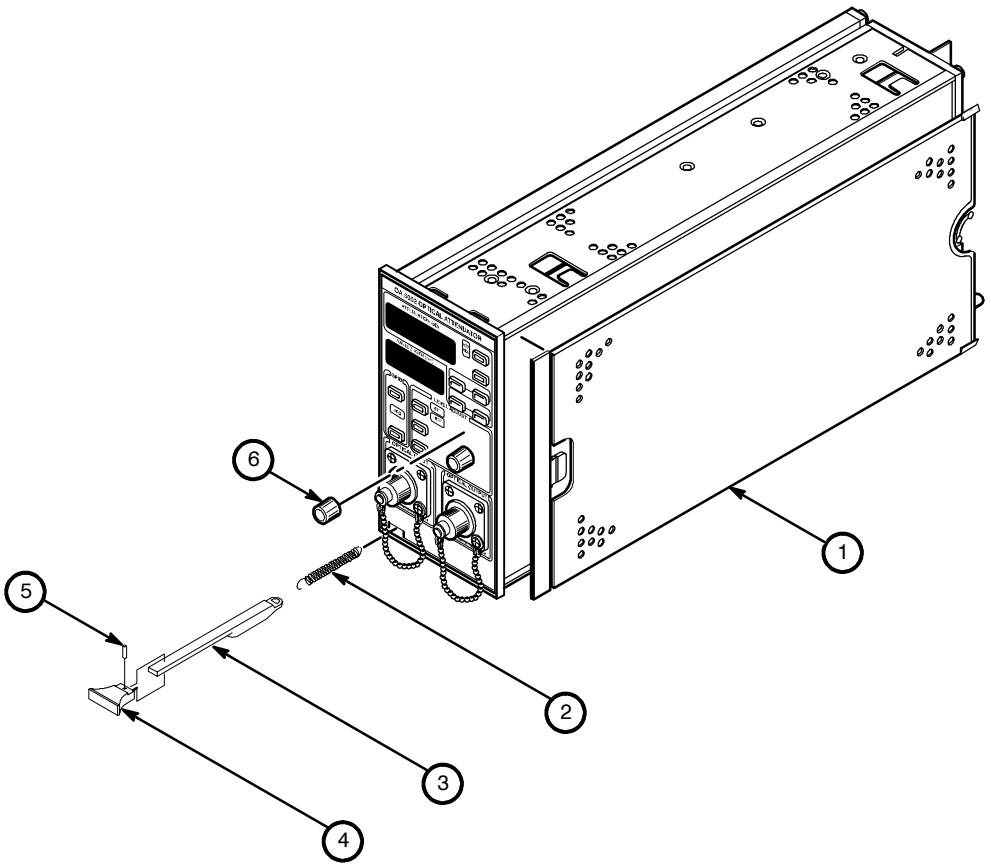


Figure A-6: OA 5000 Replaceable Parts

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CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
0J260	COMTEK MANUFACTURING OF OREGON	P O BOX 4200 M/S 16–207	BEAVERTON, OR 970764200
0JR05	TRIQUEST PRECISION PLASTICS	3000 LEWIS & CLARK HWY PO BOX 66008	VANCOUVER, WA 98666–6008
62712	SEIKO INSTRUMENTS USA INC	ELECTRONIC COMPONENTS DIV 2990 W LOMITA BLVD	TORRANCE, CA 90505
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077–0001
91260	CONNOR FORMED METAL PRODUCTS	1729 JUNCTION AVENUE	SAN JOSE, CA 95112
TK2565	VISION PLASTICS INC	26000 SW PARKWAY CENTER DRIVE	WILSONVILLE, OR 97070

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Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
A6–1	337–3039–00			2	SHIELD,ELEC:	0J260	ORDER BY DESC
–2	214–3143–00			1	SPRING,HLEXT:0.125 ID X 0.545 L, XLOOP	91260	ORDER BY DESC
–3	105–0865–00			1	BAR,LATCH RLSE:AA501	0JR05	ORDER BY DESC
–4	366–1851–01			1	KNOB,LATCH:IVORY GY,0.625 X 0.25 X 1.09	80009	366–1851–01
–5	105–0866–00			1	LATCH,RETAINING:	0JR05	ORDER BY DESC
–6	366–2166–00			2	KNOB:ABS,IVORY GRAY,0.165 ID X 0.40 OD	TK2565	366–2166–00
					STANDARD ACCESSORIES		
	020–1885–00			1	ACCESSORY PKG:O/E CONVERTER	80009	020 – 1885 – 00
	070–7612–05			1	MANUAL,TECH:INSTR,OA5000 Series	80009	070 – 7612 – 05
	620– 0057– 00			1	POWER SPLY ASSY:MAINFRAME	80009	620 – 0057 – 00
	016– 0195– 05			2	BLANK PLUG-IN PANELS,FRONT	80009	016 – 0195 – 05
					OPTIONAL ACCESSORIES		
	174–1497–00			1	CA ASSY,FBR OPT:SINGLE MODE,2M L	80009	174 –1497 – 00
	174–1385–00			1	CA ASSY,FBR OPT:SGL MODE,2M L	80009	174 –1385 – 00
	174–1386–00			1	CA ASSY,FBR OPT:SINGLE MODE,2M L	80009	174 –1386 – 00
	174–1387–00			1	CA ASSY,FBR OPT:SGL MODE,2M L	80009	174 –1387 – 00
	174–1388–00			1	CA ASSY,FBR OPT:SGL MODE,2M L,	80009	174 –1388 – 00
	174–2322–00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5	62712	174 –2322 – 00
	174–2323–00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5	62712	174 –2323 – 00
	174–2324–00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5	62712	PC/SK–20 – 002A

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